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## ORIGINAL ARTICLES.

### I.—On some Fringed and other Ostracoda from the Carboniferous Series.

By Prof. T. Rupert Jones, F.R.S., and James W. Kirkby, Esq.

(PLATES[1] XI. and XII.)

A YEAR or two ago we received from Mr. James Bennie, of the Scottish Geological Survey, a washing of Lower-Carboniferous shale from Plashetts, Northumberland, which was very rich in the remains of Ostracods. Among other species occurring therein was a *Beyrichia*-like form, ribbed as in *Kirkbya*, and with a wide fringe about the free margins of each valve.

About the same time Mr. Bennie kindly sent us another washing from the Lower-Carboniferous series, Staneshiel Burn, Roxburghshire, containing numerous examples of similar fringed and ribbed carapaces.

Since then the same or nearly allied forms have been found by us in material from other localities, chiefly in the lower portion of the Carboniferous formation.

These forms, though evidently coming near to *Beyrichia* and *Kirkbya*, can scarcely be placed in either genus, and we propose to group them under the generic name of *Beyrichiopsis*.

With them we also place a fringed species (Pl. XI. Fig. 7) that several years ago we found in an impure limestone or cement-stone of the Calciferous Sandstone, at Billow Ness, in Fife. This species has been referred to by us as identical with or nearly allied to *Beyrichia crinita*, J. and K., in recent papers;[2] and it is evidently the same as one of the forms from Plashetts, though in a different state of preservation.

Lastly, we include *B. crinita* in the new genus, for, though as yet but imperfectly known, it is a fringed species, and thus nearest to the forms under notice.

*Beyrichia radiata*, J. and K., which has a curious marginal expansion or plate, somewhat akin to the fringes of the present species, we scarcely know what to do with, though we leave it in *Beyrichia*.

The following is a brief and provisional description of the genus.

[1] These Plates have been drawn with the aid of a grant from the Royal Society for illlustrating fossil Ostracoda.

[2] Quart. Journ. Geol. Soc. vol. xxxvi. 1880, p. 567; and Proc. Berwickshire Nat. Club, vol. x. 1884, p. 323.

BEYRICHIOPSIS, gen. nov.

Carapace-valves outlined and lobed more or less after the fashion of *Beyrichia;* either unisulcate, with two roundish separate lobes, or with one subcentral and more pronounced lobe, defined by a faint sulcus on one side and a deeper furrow between it and the swollen posterior part of the valve. The anterior end rather the highest, as in *Beyrichia.* Two or more thin, curved or sinuous, outstanding ribs pass along the valves (as in some specimens of *Kirkbya*), one of which is usually placed near the dorsal edge and developed into a crest. The surface is smooth, punctate, or finely granulate. A broad, fimbriate or spinous fringe extends along and a little outside of the free margin of each valve; this and the ribs form the characteristic features of the genus, so far as known.

1. BEYRICHIOPSIS FIMBRIATA, sp. nov. Plate XI. Figs. 3–10, and Pl. XII. Fig. 5?

Valves ovate-oblong in outline, lobed, bearing two or more longitudinal ribs, and with the free margins curiously fringed and spined; height half the length, or less. The dorsal border is straight and nearly three-fourths of the valve's length; the ventral border is almost straight or slightly incurved; the extremities are rounded, the anterior being rather the highest. A large globose lobe or boss occupies the posterior third (or more) of the valve; a much smaller circular or ovate boss is dorsally placed near the anterior third; and a third, but slighter, swelling is sometimes developed in the ventral region between those already named. A thin lamella-like rib runs parallel and near to the dorsal margin; a shorter, though similar, rib is usually present along the middle of the posterior lobe; and a third (more or less sinuous) traverses the ventral region of the valve; all these ribs run out to nothing anteriorly, and end abruptly posteriorly, often with curved points. At the antero-dorsal angle of each valve, and a little outside of the exact margin, there commences a broad and delicate wing-like fringe, directed slightly outwards, and regularly marked with radiating lines or grooves. This fringe extends round the anterior extremity to beyond the centre of the ventral border, where (the groovings becoming more pronounced) it gradually breaks up into a series of flattened spines that extend, on the same plane, round the posterior extremity as far as the postero-dorsal angle. Seen from above or below, the carapace has a lobate-cuneiform outline, the anterior end being the thinnest, and the posterior almost symmetrically rounded. Surface apparently smooth. Length $\frac{1}{25}$ inch.

Examples of this species vary very little except in relative height and length.

The marginal fringe is never perfectly seen in testiferous examples,—as might be expected from its delicate character, the valves having lost it if at all knocked about before imbedment. Many specimens, however, show it more or less imperfectly, so that synthetically a very fair idea of it can be arrived at. At Billow Ness, where this species is abundant on certain planes of the cement-stone before

mentioned, the external impressions of the valves show this feature very beautifully.

Pl. XI. Fig. 7 is an internal cast of a valve with the external impression of the fringe.

Fig. 8 is a very fine testiferous example, from Staneshiel Burn, with a well-developed and ornate crest, and a curious palmate spine (?) near the postero-dorsal angle.

This species is always found in deposits of marine origin. At Plashetts it is associated with marine fossils, besides other Ostracods in abundance, such as *Kirkbya costata*, *Beyrichia radiata*, *Leperditia Okeni*, *Cytherella valida*, etc.

At Billow Ness it occurs along with *Bellerophon decussatus*, *Murchisonia striatula*, *Leda attenuata*, *Sanguinolites abdensis*, etc., and with *Leperditia Okeni* and other Ostracods.

Pl. XII. Fig. 5 represents a fringed form from Cultra, County Down, Ireland, which probably belongs to this species, though the crushed state and general bad preservation of the specimens leave the reference doubtful.

*Localities.* — Calciferous-Sandstone series. Plashetts, Northumberland; Tweeden Burn, and Staneshiel Burn, Roxburghshire; coast to the west of Billow Ness, Fifeshire[1]; ? Cultra, County Down.

Carboniferous-Limestone series. Murrayfield Pit, Linlithgowshire; and Sunnybank Quarry, N.W. of Kirkcaldy, Fifeshire.

### 2. Beyrichiopsis fortis, sp. nov. Pl. XII. Figs. 1–3.

(Var. *glabra*, Figs. 1, 2; Var. *granulata*, Fig. 3.)

Another fringed form, nearly related to *fimbriata*, occurs in the Lower-Carboniferous Shale at Staneshiel Burn, Liddlesdale. It is larger than the latter, and, were it not for the marginal fringe and longitudinal ribs, would have a very Beyrichian style of valve. We have been in some doubt whether to consider it a variety of *fimbriata* or a distinct species, but adopt the latter view, and describe it as follows:—

Obliquely subovate, lobed, longitudinally ribbed, and with a marginal fringe; height less than half the length. Dorsal border straight and three-fourths of the valve's length; ventral border boldly convex; extremities rounded, but with well-marked dorsal angles, the anterior extremity oblique and larger than the other. The posterior half of the valve is swollen and forms a large rounded lobe, in front of which, and separated by a deep and narrow sulcus, is a small oval boss; the ventral portion of the valve is tumid. A thin, sinuous rib passes obliquely across the valve from near the

[1] The thin limestone or "cement-stone" at this locality is only about one foot thick. It is a compact and very hard grey stone, showing scarcely a trace of fossils as it occurs unaltered between tide-marks. A little higher up, where it runs into the soil and a recent shell-bed (old beach), it becomes decomposed, especially about the joints, and takes the character of a soft, yellow ochre, that is easily split up with a pocket-knife or needle. The rock is then seen to be literally full of the remains (casts or impressions) of Mollusca and the carapace-valves of Ostracods. The contrast of how much is to be seen in a piece of this rotten stone in comparison with how little in a piece of the unaltered stone is most surprising and very instructive.

antero-ventral angle diagonally upwards, terminating abruptly, with a downward bend, before reaching the posterior extremity; another long curved rib, commencing a little below the first, passes along the ventral portion of the valve; and occasionally another appears not far from, and parallel with, the ventral fringe; and near to the antero-dorsal angle there is a short, curved rib, sharply pointed behind. The free margin of each valve is ornamented with a radiating fringe (and spines) similar in character to that of *fimbriata*. The surface in Fig. 3 is granulated (var. *granulata*). Length, $\frac{1}{20}$ inch.

Good examples of this species have a granulated surface, but some occur that are smooth (var. *glabra*, Figs. 1 & 2). In the latter state, and particularly when the valves are rather worn, or flattened by pressure, they simulate *Kirkbya plicata*, and are not always easy to be distinguished from it.

The ribs vary a little in development. The small one near the antero-dorsal angle is often absent; and that immediately below occasionally extends across only the posterior half of the valve.

This species is, as already stated, nearly allied to *B. fimbriata;* but differs from it in its larger size, less elongated form, more decided Beyrichian style of lobes, the granulated surface of its best form, and the absence of the dorsal rib or crest of that species.

*Localities.*—Calciferous-Sandstone series. Staneshiel Burn and Tweeden Burn, Roxburghshire.

3. Beyrichiopsis cornuta, sp. nov. Plate XI. Fig. 11.

From localities in the Carboniferous-limestone series (Lower) we have a third fringed Beyrichia-like form. It is smaller than the preceding species, has a spinose fringe all round the free margin, possesses no ribs, but in their place has one or two large spines or spikes projecting from each valve. Some of the specimens have only a spine on the large posterior lobe or boss; others have one on the anterior lobe as well. The surface is smooth; and the length is from $\frac{1}{25}$ to $\frac{1}{30}$ inch.

We name this form *cornuta*, and include it in *Beyrichiopsis* on account of its fringe.

It occurs at Linlithgow Bridge, Linlithgowshire; Woodend Quarry, Fifeshire; and Dun Quarry, Lowick, Northumberland.

4. Beyrichiopsis crinita, Jones and Kirkby.

*Beyrichia crinita*, J. & K. 1884, Proc. Berwicksh. Club, vol. x. p. 322, pl. ii. fig. 10, 11.

This species was described by one of us (from specimens collected by Mr. George Tate) in the Proceedings of the Berwickshire Nat. Club, as above quoted. We have nothing to add to this, as no additional specimens of it have been discovered. It is from the Lower Carboniferous rocks of Alnwick Moor, Northumberland.

Prof. Emmons notices and figures a fringed Beyrichian form from the Trenton Limestone, of New York State, in his "Manual of Geology," 2nd edit. 1860, pp. 95 and 100. Probably this may belong to our new genus.

5. Beyrichiopsis subdentata, sp. nov. Pl. XI. Figs. 1, 2.

Along with *B. fimbriata* in the Plashetts shale are numerous examples of another form, having longitudinal ribs, a reticulo-punctate surface, and occasional traces of denticles on the ventral and posterior borders.

It is smaller than *B. fortis*, but of similar outline, and with the valves lobed much in the same manner. A sinuous rib passes across the lower half of the valve concentric with the ventral and extreme borders; and a short dorsal rib is sometimes present on the posterior half. The surface is regularly, and somewhat coarsely, punctate, rather than reticulate. The posterior half of the free margin of some specimens is denticulated, but there are no traces of a fully-developed fringe. Length, $\frac{1}{27}$ inch.

We have examined many valves of this species, but can find nothing to show that it ever possessed a perfect fringe. The valves we meet with of *fimbriata* and *fortis* very often are without this appendage; but this is accidental, for close examination invariably shows where it has been broken off, by removal from the matrix or otherwise. In *subdentata*, however, the margins show no indication of fracture, and they are evidently found as they were originally.

*Locality.*—Calciferous-Sandstone series. Plashetts, Northumberld.

Neither of the last two species exactly agree with our definition of the genus: *B. cornuta* having the marginal fringe, but not the longitudinal ribs; *B. subdentata* possessing the latter character, but the fringe only in a very incipient state. Still we are inclined to look upon them as belonging to the same natural group as the others, though less advanced perhaps in the process of differentiation from *Beyrichia*. In fact, by taking another and less elastic view of the subject, it would be easy to look upon all the forms as but the varietal or individual differences of one species; for they certainly run very near to each other. This, however, would scarcely be in accordance with modern biological ideas; nor could we ignore the probability of the soft parts of the various forms having differed materially one from the other.

6. Beyrichiopsis simplex, sp. nov. Pl. XII. Fig. 4.

A very short time ago, Mr. Hugh Miller, of the Geological Survey, sent us a series of Ostracodous specimens from the Carboniferous rocks of Northumberland. Among them is a fringed form from the Lower Carboniferous of Warksburn, North Tynedale, that appears to be different from those already described. It occurs in single valves, imbedded in a matrix of dark grey shale, along with species *Kirkbya*, *Cytherella*, and other marine fossils.

It has a neat Beyrichian outline, with rounded extremities and a convex ventral margin. The anterior portion of the valve is much higher than the posterior. There is a well-marked subcentral sulcus, with a round, but rather faint boss in front. The surface has no ribs; but is sparsely and finely granulated. A narrow fringe bounds the free margin, and breaks up into spines posteriorly, as in other species; and at the base of the fringe runs a beaded line. Length, $\frac{1}{24}$ inch.

We name this form *B. simplex*. The full locality for it is "above Ramshaugh, Longlee Ford, Warksburn, North Tynedale."

BEYRICHIELLA, gen. nov.

There is another species (probably more than one) which comes near those described above, but which has no fringe, although it possesses a dorsal crest on each valve with a well-marked area between. It has a strong free-marginal overlap; and is quite unisulcate. This may be regarded as typical of a new genus and species under the name *Beyrichiella cristata* (Pl. XII. Figs. 6*a*, 6*b*).

This form is abundant in some of the shales and cement-stones of the Calciferous Sandstones in the East Neuk of Fife,—as at Randerstone and Billow Ness.

Note on some BEYRICHIÆ.

1. BEYRICHIA ARCUATA, Bean. Pl. XII. Figs. 12—14.

*Cypris arcuata*, Bean, 1836, Mag. of Nat. Hist. vol. ix. p. 377, woodcut, fig. 55.

*B. arcuata* was figured roughly by Bean in 1836; but, for the purpose of making comparison easy, we figure it here anew. It is a well-known and characteristic species of the Coal-measures proper, in some of the shales and ironstones of which it is found in great numbers.

It is comparatively large, being from $\frac{1}{20}$ to $\frac{1}{15}$ of an inch in length; subovate in outline, with convex valves; the dorsal margin is straight, the ventral margin arched; and the posterior end is the smallest (lowest). A deep sulcus marks the anterior half of the valves, and in front of it, close to the antero-dorsal angle, there is often a small, nearly obsolete notch, more strongly marked on internal casts. The valves are rimmed, and the surface is polished and finely punctate.

Among other localities, it occurs in Coal-measure strata at Ashby-de-la-Zouch; Agecroft Colliery near Manchester; Chesterfield; Ryhope Colliery and Claxheugh near Sunderland; and at Shotts and Carluke in Lanarkshire.

2. BEYRICHIA FASTIGIATA, Jones and Kirkby. Pl. XII. Figs. 8, 9, 10.

*B. fastigiata*, J. & K., 1867, Trans. Geol. Soc. of Glasgow, vol. ii. p. 220.

This species is smaller and has the valves more broken up into lobes than *B. arcuata*. Seen from above the outline is sub-cuneiform,—widest behind, pointed in front. The surface is punctate.

Length $\frac{1}{25}$ of an inch. It was discovered by Mr. John Young, F.G.S., of Glasgow.

It occurs in the Carboniferous-Limestone series at Bathgate (Linlithgowshire); Craigenglen, Campsie (Stirlingshire); Crossgatehall (Edinburghshire); East of St. Monans (Fifeshire); and in the Calciferous-Sandstone series West of Billow Ness (Fifeshire).

3. BEYRICHIA BRADYANA, sp. nov. Pl. XII. Fig. 11.

*B. Bradyana* is a small subovate form, with the left valve strongly overlapped by the right. It has a well-marked subcentral sulcus, and in some specimens a fainter and smaller anterior impression, with a roundish boss between. Seen from above, the outline is

compressed-ovate, pointed at the ends. Surface smooth; length $\frac{1}{35}$ of an inch. Many specimens are relatively higher and shorter than the one figured. Discovered by Mr. John Young, F.G.S.

It is found in the Carboniferous-Limestone series at Charlestown, Sunnybank Quarry, and near St. Monans, in Fifeshire; at High Blantyre, Lanarkshire; and Whitebaulks, near Linlithgow.

4. Beyrichia crateriGera, G. S. Brady, MS. Pl. XII. Figs. 7*a*, 7*b*.

Another species with a strong free-marginal overlap may be described thus. Obliquely oblong; equal in height, dorsal and ventral borders, being nearly parallel; extremities rounded, with a forward swing; a deep sulcus near the anterior third, and another passing forward to the antero-dorsal angle. Valves convex, the right overlapping the left very strongly; lateral contour cuneiform; shell thick; surface strongly reticulated. Length $\frac{1}{27}$ to $\frac{1}{25}$ inch.

This fine species was discovered by Mr. David Robertson, F.G.S., of Glasgow, in the Carboniferous-Limestone series, at Calderside Quarry, Lanarkshire; it also occurs in Lower-Carboniferous rocks at Woodend Quarry and Plashetts, Northumberland; and at Arnside, Westmoreland.

## EXPLANATION OF PLATES.

### Plate XI.

(All the Figures, except Figs. 7 and 8, magnified 25 diameters.)

Fig. 1. *Beyrichiopsis subdentata*, J. and K.; left valve; 2, right valve. Plashetts.
,, 3. *B. fimbriata*, J. and K.; left valve; fig. 4, left valve. Plashetts.
,, 5. ,, right valve. Tweeden Burn.
,, 6*a*. ,, ventral edge of left valve; 6*b*. dorsal edge of right valve. Plashetts.
,, 7. ,, cast of left valve, with impression of its fringe; magnified 40 diameters. Billow Ness, Fife.
,, 8. ,, right valve; magnified 30 diameters. Staneshiel Burn.
,, 9*a*. ,, ventral edge of left valve; 9*b*. dorsal edge of left valve; 9*c*. hinder end view; *a* and *c* showing the fringe.
,, 10*a*. ,, carapace, showing left valve; 10*b*. dorsal view. Tweeden Burn.
,, 11. *B. cornuta*, J. and K.; right valve. Linlithgow Bridge.

### Plate XII.

(All the Figures, except Fig. 3*b*. magnified 25 diameters.)

Fig. 1*a*. *Beyrichiopsis fortis*, var. *glabra*, J. and K., left valve; 1*b*. dorsal edge of right valve; 1*c*. ventral edge. Staneshiel Burn.
,, 2. ,, ,, ,, left valve. Staneshiel Burn.
,, 3*a*. ,, ,, var. *granulata*, J. and K.; right valve; 3*b*. hind end view, magnified 30 diameters. Staneshiel Burn.
,, 4. *B. simplex*, J. and K., right valve. Warksburn.
,, 5. *B. fimbriata* (?), J. and K., left valve. Cultra, Ireland.
,, 6*a*. *Beyrichiella cristata*, J. and K., carapace showing left valve; 6*b*. dorsal view. Randerstone.
,, 7*a*. *Beyrichia cratigera*, G. S. B., carapace showing left valve; 7*b*. ventral view. Arnside.
,, 8. *B. fastigiata*, J. and K., thick-shelled carapace showing cast of left valve. Sunday-night Cleugh.
,, 9 and 10. ,, right valves (thin-shelled).
,, 11*a*. *B. Bradyana*, J. and K., carapace showing left valve; 11*b*. ventral view.
,, 12. *B. arcuata* (Bean), right valve. Stylton, Durham.
,, 13. ,, ,, cast of right valve. Carluke.
,, 14. ,, ,, left valve. Longton, Staffordshire.

## II.—New Palæoniscidæ from the English Coal-measures.

By R. H. Traquair, M.D., F.R.S., F.G.S.

*Elonichthys Aitkeni*, sp. nov., Traquair.

Length, 6 to 7 inches, shape fusiform. Cranial roof bones sculptured with undulating ridges passing at times into elongated tubercles. Mandible sculptured externally with slightly undulating longitudinal ridges, which run tolerably parallel with the upper and lower margins of the jaw; dentary margin finely tuberculated. Maxilla of the usual form, its dentary margin likewise finely tuberculated, the rest of the surface covered with undulating ridges. Scales of moderate size; those of the front of the flank are higher than broad; posteriorly they become more oblique and equilateral, while towards the dorsal and ventral margins they become rather lower than they are broad. Their ornament consists of *sharp strongly-marked ridges, nearly straight and parallel*, and only occasionally bifurcating or intercalated. On the scales of the *anterior part* of the flank these ridges run rather *diagonally* over the surface of the scale from above downwards and backwards, but over the *greater part of the body* they are *parallel with the upper and lower margins of the scale*, and seldom does any greater obliquity of the ridges in the anterior and lower part of the scale give any indication of the diagonal division of the pattern which is so common in striated scales in the family Palæoniscidæ. Posteriorly, a peculiar and highly-ornamental character is given to the squamation by the fact that the lowermost ridge, uniting or not with the one next above it, is of unusual breadth, and stands prominently out. On the V-shaped ridge-scales of the caudal body-prolongation, the ornament becomes speedily obsolete, and the small lozenge-shaped lateral scales are at most marked by only one or two slight longitudinal furrows.

The length of the pectoral fin is about two-thirds that of the head, its principal rays are unarticulated for about one-third of their length. The ventrals are badly preserved, but their position seems to be intermediate between the pectorals and the anal. The dorsal is situated opposite the interval between the ventrals and the anal; both dorsal and anal fins are pretty large, and of the usual triangular acuminate shape; their rays are *delicate and slender, distantly articulated*, ganoid and smooth, save that now and then a single longitudinal furrow is seen especially just before bifurcation sets in. The caudal is large and deeply cleft; the articulations of the rays of the lower lobe are a little closer than those of the dorsal; in the upper lobe the joints become so short as to look nearly square-shaped.

*Remarks.*—Though hitherto undescribed, this fine species is pretty well known to collectors in the West of England, and cannot be confounded with any other. I have named it after the late Mr. John Aitken, of Bacup, Lancashire, who lent me the beautiful specimen, of which a figure will shortly appear in my memoir on Carboniferous fishes in course of publication by the Palæontographical Society.

*Geological Position and Localities.*—Lower Coal-measures. Copy

Coal Mine, Cliviger (collected by the late Mr. Aitken): Arley Mine, Burnley, Lancashire (coll. of Mr. J. Wilde, Ashton-under-Lyne): Dalemoor Rake Ironstone, Stanton, Derbyshire (British Museum and Museum of Practical Geology): Millstone Grit Shales, Danebridge (Mr. J. Ward). There is a specimen in the Museum of Practical Geology, labelled from Ladieswell Colliery, Staffordshire, but in Mr. Ward's opinion the specimen more probably came from the Lower Coal-measures of the Cheadle district.

*Elonichthys microlepidotus*, sp. nov., Traquair.

I have only seen two specimens of this interesting form, which have been kindly lent to me by Mr. Ward.

The length of the more perfect of the two is $3\frac{3}{8}$ inches; but as it is broken off immediately behind the anal fin, we may justly estimate the original length of the fish at not less than five inches. The external markings of the head-bones are not well seen, except in the case of the lower jaw, which is ornamented by wavy longitudinal branching and anastomozing ridges. In this specimen the mouth is wide open, as is also the gill-cleft, owing to the drawing forward of the suspensorium; the opercular bones are rather narrow, and beneath them and the mandible the branchiostegal rays may be counted. The scales are *small* in proportion to the size of the fish, and their markings consist of only a *few strong ridges passing horizontally or with only a slight obliquity across the scale*. Only the base of the pectoral fin is seen, the other fins are large, and have the form and relative position characteristic of this genus. Their rays are very numerous, fine, and closely set; their joints longer than they are broad, and their surfaces show traces of fine longitudinal striation.

*Remarks.*—The relative smallness of the scales and their peculiar simple bold ornament distinguish this species from any other with which I am acquainted.

*Geological Position and Locality.*—Knowles Ironstone Shale, Longton, Staffordshire, in the collection of Mr. John Ward, F.G.S.

*Rhadinichthys macrodon*, sp. nov., Traquair.

The specimen upon which this species is founded measures five inches in length, but it is broken off just behind the commencement of the caudal fin, as indicated by the dorsal ridge scales; the length of the head is $1\frac{1}{4}$ inch, and the depth of the body nowhere exceeds one inch. Consequently, the general aspect is that of a fish of slender form, but the specimen cannot be relied on as showing the original shape, as the scales are broken up and confused, and the fin-rays almost entirely wanting. The head exhibits the typical palæoniscid structure,—the suspensorium being very oblique, the gape wide, and the usual arrangement of opercular and branchiostegal plates being shown; the bones are, however, seen almost exclusively from their internal surfaces. Both jaws are armed with stout, conical, incurved teeth of *unusually large* proportional *size*, those of the maxilla measuring $\frac{1}{12}$ to $\frac{1}{10}$ inch in length; the small external ones are not visible. The scales are of comparatively large size, those of the anterior part of the flank having their exposed areas covered with

delicate ridges and furrows, which are nearly parallel with the upper and lower margins of the scale, though they tend to turn upwards anteriorly; the posterior margin is sharply and prominently denticulated. As we proceed backwards, the scales lose the sharpness of their ornament, and become nearly smooth towards the tail, though the caudal V scales remain prominently striated. The origin of the pectoral fin is present, though not well shown, and here the principal rays seem unarticulated. A few broken up ray-joints mark the position of the dorsal and anal fins, the former occurring 3 inches, the latter $3\frac{3}{4}$ inches behind the front of the head.

*Remarks.*—The condition of the specimen renders its generic determination a matter of great uncertainty, but I am inclined to place it in *Rhadinichthys* for the following reasons:—(1), the apparent elongation of the body, on which, however, little weight can be placed; (2), the resemblance of the scales, in shape and ornament, to those of the typical *R. ornatissimus*, Ag. sp.; (3), the appearance of the broken rays of the root of the pectoral fin. Specifically I designate it as new, as I am not acquainted with any other form in which teeth of such large proportional size occur with scales of similar conformation and markings.

*Geological Position and Locality.*—Knowles Ironstone Shale, Fenton, Staffordshire, in the collection of John Ward, Esq., F.G.S.

(*To be continued.*)

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## III.—On the Lobe-line of Certain Species of Lias Ammonites described in the Monograph by the late Dr. Wright.

By S. S. Buckman, F.G.S.

WHILE recently turning over the plates of this Monograph, my attention was arrested by the lobe-line figured on plate 63, and on looking at the explanation of the plate given on the opposite page, I was much surprised to see that it was stated to be the "*Lobe-line of Harpoceras ovatum, magnified.*" On the same plate, just below (fig. 4) is a side view of the *Harp. ovatum* with its lobe-line in situ, and I suppose it to be this lobe-line that is magnified. But there must surely be some mistake here. Compare the lobe-line, fig. 7, with that on fig. 4, and notice the much greater width of the siphonal saddle in fig. 4 (than in fig. 7), where, on account of the curvature of the fossil, it would be really smaller. To say nothing of the obliquity of the inner portion of that on fig. 4, where is the first auxiliary lobe (nearly as large as the inferior lateral in fig. 7) to be found in fig. 4? I think it will be apparent that for some reason or other the two lobe-lines are different. But is the lobe-line, fig. 7, the correct lobe-line for such a species as the *Harp. ovatum* here figured? I must say No! Turning for a moment to Wright's description of the lobe-line of *Harp. ovatum*, page 446, we find it stated, "*The suture-line is of the radians type.*" This is true enough of the suture-line shown on fig. 4, but I think any one who has paid attention to the suture-lines of this class of Ammonites could not possibly say that fig. 7 was a lobe-line of "*the radians type.*"

The further description given is accurate as regards fig. 7, but it

cannot be said to apply to fig. 4. In fact the suture-line fig. 7 belongs to that group of shells of which the specimen of *H. elegans* (figs. 1, 2, 3 on the same plate) is characteristic, and that by some means or other an oversight has occurred and the suture-line of this specimen (*Harp. elegans*) has been figured in mistake for the one of *H. ovatum*. That it is no fault of delineation I feel positive, because fig. 4 is characteristic of the group to which *Harp. ovatum* would belong, while fig. 7 is characteristic of the group to which *Harp. elegans* belongs. Compare for confirmation of this opinion the suture-line, fig. 7, with the suture-line given by D'Orbigny (Pal. franç. Terr. jurass. plate 62) to *Am. primordialis*—otherwise *Am. opalinus* (Reinecke),—a very near ally of *Am. elegans*, or compare it with the suture-line of a specimen of *Am. concavus*, Sow. These shells belong to a group having a practically identical suture-line not at all like that of *Harp. radians*. Now turn to plate 80, and at first sight the evidence appears against me. Here we have in fig. 3 a suture-line which I consider is of the *opalinus* type, called the suture-line of *Harp. aalense*, and in fig. 5 the suture-line of apparently the *radians* type called the suture-line of *Harp. opalinum*; but let us now look at his description of the suture-line of *Harp. aalense*, page 459, and *Harp. opalinum*, p. 464, and we see that the descriptions *do not in any way agree with the figures*. It is in figure 3, not 5, as stated, that we find the siphonal saddle divided into two unequal portions, and the auxiliary lobes large and two smaller auxiliaries, because there are no auxiliary lobes in fig. 5. The fact is Wright has correctly described the lobe-lines belonging to the two species, but has never noticed that they were wrongly numbered, whilst on page 446 (plate 63) he has described as *the suture-line* of *Harp. ovatum* a suture-line belonging to a different group of species altogether. I have proceeded no further at present, as I only happened to notice these suture-lines because they were necessary to me in my own work. But having noticed the errors mentioned, I have penned these remarks, not with the intention of detracting in the least from the excellence of Wright's monograph, but to call attention to the subject, so that it may not mislead others or be the unsound basis of argument should any discussion arise concerning the validity of suture-lines as a means of identification.

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## IV.—On Some New or Imperfectly Known Madreporaria from the Inferior Oolite of Oxfordshire, Gloucestershire and Dorsetshire.

By Robert F. Tomes, Esq.

(*Continued from* p. 398.)

### Adelastræa consobrina, Edw. and Haime, sp.

(not *Synastræa consobrina*, d'Orb., Prodromus).

We are informed by M. Ferry that d'Orbigny was supplied with the greater part of the Corals of his Bajocien by M. Eugene Beabeau, of Langres, who has stated of the present species that it was first named *Calamophyllia glomerata* by d'Orbigny, and afterwards by an error *Synastræa consobrina*, and further, that he at the same time

described in his Prodromus another species under the same name. MM. Milne Edwards and Haime, it appears, were misled by this error, and referred the Coral sent by M. E. Beabeau, to the *Synastræa consobrina* of the Prodromus. This in brief is the statement of M. Ferry, and it is obvious that the *Synastræa consobrina* of the Prodromus, and the *Clausastræa consobrina* of MM. Milne Edwards and Haime are not the same, and that the latter is the Coral forwarded by M. E. Beabeau from Langres.

As *Confusastræa* had been proposed as a generic name as long ago as 1849 by M. d'Orbigny, and several species placed in it by him in 1850, and recognized by Milne Edwards and Haime, M. Ferry appears to have entertained no doubt about the generic relationship of the present species, and he therefore unhesitatingly places it in the genus *Confusastræa*. An allied species *C. ornata* occurs also at Langres, which differs only from *C. consobrina* in having larger calices. Of this M. Ferry gives a description, in which mention is made of some peculiarities which may here be noticed. The corallum, he informs us, is formed of a successive aggregation of corallites, with lateral and marginal buds, joined with one another by a rudimentary wall. He further observes that the corallites are often superposed, the young calices frequently implanted in the old ones, and that they start from a common base, formed sometimes of a single individual.

No description is given of *C. consobrina*, but it is said to resemble the last species, but with calices which are constantly of smaller diameter.

The specimens from the Cheltenham district correspond with great accuracy with the description given of *C. ornata* by M. Ferry, except that the calices are smaller, and their diameter agrees very well with that given of those of *Clausastræa consobrina* by MM. Milne Edwards and Haime, which is undoubtedly the same species as the *Confusastræa consobrina* of M. Ferry. Budding occurs laterally and in the depressions between the calices of these Cheltenham examples, and the growth of one calice within another (rejuvenescence) is not unfrequent in them. This Coral appears to be plentiful in the Lower Coral-bed in the Sheepscombe valley, near Painswick, and I have seen a specimen taken from the Oolite marl at Leckhampton Hill.

Of *Adelastræa tenuistriata* I may remark that although when unworn it is quite unlike an *Isastræa*, yet when the septa are worn down, it is difficult to distinguish from *Isastræa tenuistriata*. With the latter it has often been confounded. The marginal budding will, however, always identify it. Its relationship to the fissiparous genus *Cladophyllia*, suggested by Professor Duncan, is entirely unsupported by evidence.

ISASTRÆA TENUISTRIATA, Edw. and Haime.

Since the appearance of my former paper I have examined a number of specimens of this species from the Lower Coral-bed at Crickley Hill and Birdlip Hill, from the Lower Trigonia Grit at Juniper Hill near Painswick, and from other localities in the

Cheltenham district. I have also obtained it from the Upper Coral-bed in the Slad Valley near Stroud. It is now therefore obvious that it has a considerable vertical range in the Inferior Oolite. A specimen from Birdlip shows its method of gemmation very clearly. It takes place either on the exposed margin of the wall between the calices or a very little within the calice, as even when still very small it is impossible to say from which calice the young one proceeded.

ISASTRÆA DEPRESSA, Tomes.

Besides the localities already mentioned in my communication on Inferior Oolite Corals, I have now seen examples from the Lower Coral-bed at Birdlip, and at Juniper Hill in the Painswick valley. I have also a specimen which was given to me by the late Dr. Bowerbank, with the information that it had come from Dundry Hill. Another specimen from the same locality is in the Northampton Museum. There is also one in the Museum at Oxford, which was taken from the Inferior Oolite in the Hook Norton cutting of the Banbury and Cheltenham Railway. The presence of this species at the latter place might lead to the conclusion that the lower beds of the Inferior Oolite are not unrepresented there.

CHORISASTRÆA GREGARIA and C. OBTUSA.

I enter with some reluctance into a repetition of what I have already insisted on respecting some corals which I placed in the genus *Chorisastræa*. So far as the two English species, *C. gregaria* and *C. obtusa*, are concerned, everything depends upon their mode of increase. If it is by fissiparity, then are these species simply Thecosmilians, but if accomplished by means of gemmation, some other genus than *Thecosmilia* must be chosen for their reception. Now, Professor Duncan himself, speaking of these same corals (Quart. Journ. Geol. Soc. vol. xlii. p. 128), says, "An attempt was made to include the well-known species of *Thecosmilia*, which *at first increase by gemmation* and then by fissiparity" (*i.e.* to include them in *Chorisastræa*). The words have been given in italics by me. A few pages further on (p. 113), he refers to one of my own figures in proof of fissiparity in *Chorisastræa gregaria*. That figure represents the earliest period when increase takes place, just at the time when the corallum ceases to be simple and becomes compound. This, according to Professor Duncan's own words, should be the period for gemmation, instead of fissiparity. The two statements are of course inconsistent with each other. The real fact is, gemmation and nothing else takes place, and we have exactly the same process which is represented by the figures of *Chorisastræa corallina*, From., *C. neocomiensis*, From., and *C. dubia*, Becker. One of the figures of the latter species (from the Corallien of Nattheim) bears a strong resemblance to some of the more simple examples of *C. gregaria*, and answers to the descriptive words of MM. Milne Edwards and Haime which they applied to their *Thecosmilia gregaria*. They say that the corallites of that species differ from those of *Thecosmilia* by "remaining in general *grouped in fasciculi* to a considerable distance

from the parent calice." This is precisely what takes place in the various speices of *Chorisastræa*, and had those celebrated palæontologists seen and examined young examples at various ages, I do not for a moment believe that they would have placed *C. gregaria* in the genus *Thecosmilia*.

*Chorisastræa obtusa* from the Great Oolite differs chiefly from the preceding in being smaller. But some of the dwarfed examples of *C. gregaria* very closely resemble it. However, *C. gregaria* may at all ages be known by the greater thickness of its septa outwardly, that is, near the mural region. This peculiarity is observable in individuals, the corallum of which is so young that it has only the thickness and size of a small coin. The specimen of *C. obtusa* figured by Prof. Duncan is not very characteristic, one of that height would commonly have four or five calices, or even more.[1] Such examples as the one figured are however common in the Fairford Coral-bed.

In support of *Chorisastræa* as a genus I may only remark that if not Thecosmilian, the species I have here mentioned must be placed either in *Chorisastræa* or *Latimæandra*, and it can hardly be said that they fall properly into the latter.

CHORISASTRÆA, sp.

Peduncular portions of a species of coral referable to this genus have been obtained from the beds under the Pisolite at Crickley Hill, and from a sandy bed overlying the Upper Lias sands at Dover's Hill near Chipping Campden. All the specimens examined have very numerous, thin, and uniform septa, and they are probably attributable to some undescribed species.

Genus PHYLLOGYRA, Tomes, Q. J. Geol. Soc. vol. xxxviii. p. 430.

Since the definition of this genus appeared, I have examined some young examples of *Phyllogyra Etheridgei* from the Trigonia Grit of Leckhampton Hill, which enable me to confirm the characters I have before assigned to the genus. The smallest of these is not more than an inch in diameter. It has a flattened lenticular form, with a central large calice and a thin lobular outer margin, in the lobes of which gemmation is actively taking place, precisely as it does in the margins of small examples of *Chorisastræa gregaria*. Between the marginal lobes are subcristiform ridges, just as in that species, and such as I have figured in plate xviii. illustrating the paper above quoted. It is obviously by gemmation, and not by fissiparity, that increase in this genus takes place, as the central calice is not in any way interfered with by the simultaneous growth of a circle of new calices in the distal ends of the surrounding septal costæ. Gemmation as it takes place in *Phyllogyra* is precisely as in *Latimæandra*, and as it has been figured by Prof. Duncan himself in his Supplement to the British Fossil Corals, plate v. fig. 7 of part ii.

It is by no means improbable that *Phyllogyra Etheridgei* and *Chorisastræa gregaria* may prove to be forms which differ only from each other; the one by having a depressed and expanded growth,

[1] Since writing the above the specimen figured by Prof. Duncan as *Thecosmilia obtusa* has come into my hands. Of it I shall have more to say on a future occasion.

and the other by having a subdendroid form. For the present I leave them where they are, but must enter my earnest protest against there being any near affinity with *Symphyllia* in the Oolitic form now under consideration.

PHYLLOGYRA SINUOSA, Tomes.

I have lately met with several examples of this species in the Lower Trigonia Grit near Cheltenham, but in no instance in the Coral-bed at Crickley. It has not, indeed, been observed in the Lower Coral-bed at any locality, though it most frequently occurs in the Oolite marl, or third Coral layer.

PLATASTRÆA ENDOTHECATA, sp. nov. (Plate X.[1] Figs. 1, 2, 3, 4.)

*Clausastræa Conybeari*, Tomes, Proc. Geol. Assoc. vol. vi. no. 4.

The present species, the occurrence of which I have already recorded, under the name of *Clausastræa Conybeari*, must, with the allied species from the Great Oolite of Bath, be referred to the new genus *Platastræa*. Specimens from the Inferior Oolite of Hook Norton are for the most part fairly preserved, and sometimes when broken through, show the structure of the septa and the dissepimental tissues very clearly.

The corallum is rudely lenticular, and not very large. The upper surface is moderately convex, sometimes almost flat, and never much elevated, and the outer margin is rather thin, but rounded rather than angular. The under surface is much more prominent than the upper surface, in some specimens almost subpeduncular, with a central point indicating a former attachment. The common or basal wall is rudimentary, and has intermittent and narrow rings of epitheca. The radiating mural costæ are thin, and the spaces between them are wide and filled with dissepiments. The calices have a more or less quadrangular or rounded outline, and are shallow. The septa are all of them continuous with those of other calices, but they often form an angle where they meet and unite between the calices. They are very stout over the mural region, but speedily become thinner as they approach the visceral cavity. The margins of all of them are denticulated, the teeth consisting of rather large, regular, and rounded tubercles, the greater diameter of which is across the septum. There are four cycles of septa in six systems. In some systems the fourth cycle is incomplete, while in others there are a few very rudimentary septa of the fifth cycle.[2] The primary septa extend to the fossula and meet, the secondary ones are very little shorter than the primary ones, and those of the tertiary cycle are

[1] This Plate was published in the September No. with the first part of this paper.

[2] I must differ wholly from Prof. Duncan when he says that there are never two rudimentary cycles in the same calice. There are not ever, to the best of my knowledge, two rudimentary cycles in the same system, but there may be, and often are, in the irregularly developed calices of Jurassic Madeporaria, rudimentary septa of quite different ages in different systems. The third cycle may be rudimentary in one and complete in another, in which a fourth may have even commenced its growth. Such irregularities are frequent after recent rejuvenescence, one side of the calice having perhaps the full complement of septa, while the other may have only the earlier developed cycles.

a little more than half the length of those of the primary cycle, while those of the fourth cycle are quite short.

The dissepiments are very numerous; stout, arched, and they completely fill up the loculi. They continue so high up in them that they are seen almost close beneath the denticulations of the septa. The diameter of a large corallum is from three to four inches, and the height about one inch. The diameter of the calices is half an inch. Increase takes place by gemmation in the interval between the calices.

Although allied to *Platastræa Conybeari* from the Great Oolite, the present species may be readily distinguished from it by its much smaller size and regularly lenticular form. Again, the septa of *P. Conybeari* meeting in the centre of the visceral cavity, are much thickened quite low down in it, and these form a mass which, when those parts of the septa which are above it have been worn down, comes in view, and has so much the appearance of a columella as to have led MM. Milne Edwards and Haime to place the species in the genus *Plerastræa*. Nothing of the kind is observable in *Platastræa endothecata*.

I take the present opportunity of making a few remarks on *Platastræa Conybeari*. It is not rare at Coombe Down, from which place the type-specimens were obtained. It is sometimes of great size, and although, generally speaking, of a globose form, is often extremely irregular in its outline, and the calices on some parts have a corresponding irregularity in shape. When these irregular calices are worn down, they present precisely the appearance of those shown in the figure of *Clausastræa Pratti* figured in the History of British Fossil Corals. But the more regular calices of *Isastræa Conybeari*, figured on the same plate, would never by any condition of fossilization or any amount of wear resemble those of the then supposed *Clausastræa*. But indeed no one except Prof. Duncan has suggested such a possibility.

Of the type-specimen of *Clausastræa Pratti* (afterwards *Plerastræa Pratti*) the original describers observe that it is so ill preserved that they could not give a complete description of the species from it. Notwithstanding this, no doubt seems to have crossed Prof. Duncan's mind as to its fitness to furnish a satisfactory description, and he has accordingly entered quite recently into its details.[1] I also have lately examined the type-specimen, and can confirm what has been said of its unfavourable condition by MM. Milne Edwards and Haime. It is a young example and bears a very close resemblance to many of the specimens from Coombe Down. The supposed papillose columella observed in some of the calices is nothing more than the blending of the septa in the centre of the calice, the denticulations of which, resembling in shape those I have figured on the plate accompanying this communication,[2] are yet traceable in that part of the calice which has been subjected to the least wear—that is to say, in the centre. All other parts of the septa have been worn down quite smooth.

[1] Quart. Journ. Geol. Soc. vol. xlii. p. 138.

[2] Plate X. Figure 3.

In the description of the so-called *Clausastræa Pratti* by the original describers it is stated that the calices are not separated by a distinct wall; all the Coombe Down specimens I have seen, whatever their condition, accord in this particular with the type. They are equally destitute of surrounding wall, whether they have the irregular form of those of *Clausastræa Pratti*, or the more regularly defined ones of *Isastræa Conybeari*. Turning to the description of the genus *Plerastræa* by MM. Milne Edwards and Haime, M. de Fromentel, and Prof. Duncan, I observe that special mention is made of the presence of walls surrounding the calices. I must therefore still contend that *Platastræa* is generically distinct from *Plerastræa*, which has distinct walls bounding the calices.

Further, I must continue to assert the identity of the two species *Isastræa Conybeari* and *Plerastræa Pratti*, the latter being nothing more than a small specimen having an irregular growth, and a corresponding irregularity in the development of the calices. And I must repeat my assertion that the same specimen of this variable species will on different parts present the appearances represented by the figures given by MM. Milne Edwards and Haime of *Isastræa Conybeari* and *Plerastræa Pratti*.

### Genus Leptophyllia, Reuss.

The conclusions of M. Pratz respecting the structure of the corallum of the genus *Leptophyllia* were based on the examination of specimens of the very species on which Reuss established the genus. They were obtained from the Cretaceous formation at Gosau, and he observes that proof is yet wanting that these Cretaceous and other subsequently described species from the Oolites are generically identical. At present my knowledge of the Oolitic Leptophylliæ is confined to the examination of a few examples of a small species from the Inferior Oolite. In these I observe the same form of pseudo-synapticulæ as in the Gosau Leptophylliæ, and in the genus *Thamnastræa*; they therefore, very probably, appertain to the genus *Leptophyllia*. One of these small and malformed Oolitic *Leptophylliæ*, from the Inferior Oolite of Dorsetshire, has been figured and described by Prof. Duncan under the name of *Podoseris constricta*.

### Leptophyllia Flouresti, E. de From.,

Pal. Franc. Terr. Jurass. Corall. p. 93, pl. 27, figs. 1–4, Oct. 1866.

One example of this species has been taken from the Oolitic Marl at Leckhampton by me, and I have another given to me by my friend Mr. W. C. Lucy, which he obtained from a bed of angular oolitic gravel near Painswick. The Painswick specimen is misshapen, and has a curiously close resemblance to figure 3 of the plate above quoted.

### Genus Thecoseris, E. de From.

*Palæoseris*, Duncan.

Since the publication of my paper in which the description of *Thecoseris polymorpha* appears, I have examined a specimen of that species which had been split through vertically, showing the sides

of the septa with great distinctness. The so-called pseudo-synapticulæ are very clearly shown, and appear as ledges passing continuously across the septa in lines parallel to the septal edge. There is not the slightest indication of perforations between these ledges, but there are well-defined dissepiments low down in the corallum. The genus *Thecoseris* differs wholly from *Leptophyllia* in having imperforate septa and an investing wall with a well-developed epitheca, giving to the calice a clearly-defined and prominent margin. These differences sufficiently characterize *Thecoseris*, and at the same time distinguish it from *Leptophyllia*. They also afford good reasons for declining to accept the position of a subgenus assigned to them by Prof. Duncan.

When I stated my belief that *Palæoseris* would be found to be identical with *Thecoseris*, I did not know that Zittel had already referred it to that genus. That *Thecoseris* should be a Cretaceous as well as a Jurassic and Tertiary genus, might be anticipated, and accordingly a species has been described in Stoliczka's work on the Cretaceous Corals of Southern India.

THAMNASTRÆA EXPANSA, sp. nov.

I have met with a *Thamnastræa* at Birdlip Hill, Gloucester, in a Coral-bed which is an extension of the one at Crickley Hill, having characters which do not accord with those of any species I am acquainted with, and I therefore describe it under the above name.

The corallum is broad and saucer-shaped, very thin, and has a slight peduncle. The margin is extremely thin and wavy. The epitheca is well developed and concentrically wrinkled. The calicular surface is very slightly concave, and a little deeper in the centre. The calices are extremely small, circular, and regularly distributed, and there is very little disposition in the septal costæ towards the parallel arrangement observable in so many species of *Thamnastræa*. About twenty-four septa enter into and form the calice, twelve of which unite in pairs at the fossula. The others are short. The fossula is small, round, but not very deep. All the septa and septal costæ are very delicately papillated.

Diameter of the corallum, 3 inches; its thickness, $\frac{1}{2}$ inch.

Distance from centre to centre of the calices, 1 line.

THAMNASTRÆA HETEROMORPHA, sp. nov.

The corallum has a very complicated outline, somewhat resembling that of *Dimorphophyllia*, but much more irregular and less compact. Proceeding from a common centre, it expands upwards and outwards into a considerable number of leaf-like and lobular parts, which are in clusters, and have openings through and between them. The calicular surfaces are horizontal and divided; they are numerous, and having their margin turned up, present extremely irregular shallow cavities. All the under parts of these leaf-like lobes have a well-developed and rugose epitheca.

The calices are for the most part in rows corresponding with the outer margin of the lobes. They are shallow, but have a well-defined and rather large fossula. There are from sixteen to eighteen

septa, of which twelve are of equal length and form the fossula. The rows of calices are connected by septal costæ, which are nearly parallel, and run towards the outer margin of the lobe. Very few anastomoze, but all, as well as the septa, are regularly papillated. In the fossula is a well-defined columella consisting of about twelve regular styliform papillæ.

Height of the corallum, about 1½ inch, and its greatest diameter about 3½ inches. The calices are distant from each other about one line.

I have met with a few specimens in the Oolite Marl at Leckhampton Hill, but not at any other place.

DIMORPHARÆA EXPANSA, sp. nov.

I possess four specimens of *Dimorpharæa*, from the Inferior Oolite of East Coker, they are very distinct from *Dimorpharæa Oolitica*, which I describe as follows:—

The corallum is very broad and thin, and the upper and under surface have about the same degree of convexity. The largest specimen has a diameter of four inches, while in thickness it does not exceed half an inch. The outer margin of all the specimens is quite thin. In all of them the mural costæ are visible on the under surface, only a very small quantity of epitheca being present. This is distributed in patches. These costæ are straight, uniform in size, and they radiate from a centre.

The middle or parent calice has very little prominence, and is only a little larger than the surrounding ones, which are ranged around it in circles, so irregularly that they look almost scattered. There are, however, three circles of secondary calices, and outside the external one the septal costæ are prolonged to a length exceeding the distance between the circles. From this it might seem that three is the full complement of circles, unless the distance between the circles increases rapidly as the corallum enlarges.

From twelve to sixteen septa enter into and form the calices. In the most regularly formed there are twelve, of nearly equal length and thickness, extending to the fossula, but they do not enter into it. They have perforations, which are not numerous, but are large and distinct. The septal costæ are of equal thickness with the septa, as well as equally thick throughout; they are straight or wavy, rarely curved, and have a radiate arrangement. The breadth of the intervals between them rather exceeds their own thickness.

At present I have been unable to examine specimens having the septal edge complete.

COMOSERIS VERMICULARIS.

A specimen of *Comoseris* which I took from the friable Pisolite at Crickley Hill is obviously specifically identical with the specimen I have already referred to *C. vermicularis* obtained from the overlying Coral-bed at that place.[1] It is a young and worn example, but is very instructive as to the habit of growth of the species. A short

[1] Quart. Journ. Geol. Soc. vol. xxxviii. p. 448.

peduncular foot is surmounted by a tuber-shaped top, which is composed of overlapping leaflets, and where the lateral margins of these meet on the upper surface, they curl up and form ridges having precisely the same sinuosity as the margins of the leaflets. It is only, however, at the outside of the corallum that the outline of the leaflets can be satisfactorily traced. On the whole of the central part they are too much fused together to be followed excepting as sinuous ridges, which being worn down, reveal the hidden wall within.

In 1884, when Prof. Duncan published his Revision of Families and Genera, he did not admit that there was any wall in the collines of *Comoseris*; but in his recently published paper in the Journal of the Geological Society he acknowledges that there is a false wall. This is a step in the right direction. With patience and further research a true mural structure may yet be arrived at.

This is the only species I have met with which is common to the Pisolite and the overlying Coral-bed; but as the specimen from the former deposit was found in the friable or disintegrated part, it may have fallen from above and have been embedded.

### Phylloseris incrustata, Mich. sp.

*Alveopora incrustata*, Mich. Icon. Zooph. p. 111, pl. 25, fig. 8, 1840–47.
*Microsolina incrustata*, M. Edwards, Hist. Nat. Corall., tom. iii. p. 201, 1860.
*Phylloseris*, sp. Tomes, Q. J. G. S. vol. xxxviii. p. 448, 1882.

The species of *Phylloseris* which I indicated at page 448 of my paper on Inferior Oolite Corals is obviously identical with the *Alveopora incrustata* of Michelin. Although described by that author as a dendroid species, and having the "rameaux" partially covered by an irregular "croute," it is obvious by the figure that it has more of a digitate than a dendroid growth. That it is a second species of *Phylloseris*, differing chiefly from *P. rugosa* in the form of the corallites and the size of the calices, I have no doubt. The epitheca extends upward by degrees and obliterates the calices, just as it does in *Phylloseris rugosa*.

### Latimæandraria concentrica, Tomes.

*Oroseris concentrica*, Tomes, Quart. Journ. Geol. Soc. vol. xxxviii. p. 441.

In a paper on the Madreporaria of the Coral Rag (Quart. Journ. Geol. Soc. vol. xxxix.) I suggested that a species of *Oroseris* which I had before described as *Oroseris concentrica*, probably appertained to another genus. I now place it in *Latimæandraria*, and I do so for the following reasons. As clearly pointed out by me, *Oroseris* may be recognized by its mode of gemmaparous increase, which is calicular or marginal, while in *Latimæandraria*, *Thamnastræa*, and some other genera, it is intercostal. As it is also intercostal in the present species, I now place it in the former of these genera.

In conclusion I wish to render my very sincere thanks to Mr. Hudleston, Mr. Buckman, and Mr. Jas. Windoes for their liberal assistance in the use of specimens from their several collections.

## V.—On a Deep Boring in the New Red Marls (Keuper Marls) near Birmingham.[1]

By W. Jerome Harrison, F.G.S.

THE Triassic strata which form the country surrounding Birmingham consist of the usual divisions of sandstone and marl; the sandstones predominating below, the marls above. In the immediate neighbourhood of the town, the sandy beds are divided from the marly or clayey strata by a dislocation or line of fault which runs from north-east to south-west, taking a line from Erdington to Rubery, and traceable altogether for a distance of about twenty miles. The fault runs through the town of Birmingham nearly parallel to the River Rea, and from a quarter to half a mile west of the present bed of the river. The Lower Keuper sandstone, which forms a surface band one to two miles in width on the west of this fault, is a porous stratum about 200 feet in thickness. It is underlain by the Bunter Pebble Beds, 300 to 400 feet in thickness, which crop out further to the west, and which contain an inexhaustible supply of water. From three deep wells in the suburbs of Birmingham—two on the north at Perry and Witton, and one on the south near Selly Oak—the Corporation Waterworks obtain daily a supply of over eight million gallons of water, most of which comes from the Pebble Beds, which occupy the lower portion of each well or bore-hole. The water is of good quality, showing from nine to fifteen degrees of hardness.

On the east of the line of fault a very different state of things prevails. The rocks on this side have been dropped vertically some six or seven hundred feet. Here the surface is composed of the Keuper Red Marls, which form a broad band ten or twelve miles in width, extending from Birmingham to Shustoke. The water-supply of this tract—which has a considerable extension to north and south from Tamworth to Warwick and Redditch—is wholly derived from superficial sources, such wells as exist drawing their water from the post-glacial sands and gravels which lie here and there in hummocks on the Red Marls.

As the population on this agricultural plain of Warwickshire is comparatively small and scattered, and as there are no manufacturing towns in the district, it is, perhaps, not surprising that until quite recently no attempts have been made to reach the buried waters which probably exist in the Bunter and Keuper Sandstones that underlie the Red Marls on the east of the line of fault. The chief obstacles to such an undertaking are the unknown—certainly considerable—thickness of the Red Marls; and the fact that no one likes to be the first to experiment in a matter in which—while there is certainly a possibility of failure—any good result obtained would be quite as much for the benefit of one's neighbours as for one's self. It would seem that such borings might be executed by Government,

[1] Read before Section C. (Geology), British Association, Birmingham, September 3rd, 1886.

or by the County Boards which it is proposed to establish, the cost being defrayed by a small tax levied on the landowners of the district.

The work of the Geological Survey has given us some information as to the probable thickness of the Red Marls. Prof. Jukes, writing of South Staffordshire,[1] says:—"The total thickness of this subformation cannot be much less than 600 feet;" and Mr. Howell, speaking of this very district,[2] states that "south of Birmingham the Keuper Marls attain a thickness of nearly 600 feet," and again adds "in this district, the Red Marl attains a maximum thickness of about 600 feet." However, he gives a section of a boring on the Lindley Hall Estate (four miles north of Nuneaton), about which, although a depth of 660 feet was attained, he says, "it does not seem certain that they got through the Red Marl series; some of the lower beds, however, may belong to the Lower Keuper Sandstone." In a deep boring for water, at Rugby, after passing through 400 feet of Lias and seventy feet of Rhætic Beds, the New Red Marls were pierced, and found to be 670 feet in thickness; at a depth of 1140 feet the Keuper Sandstone was reached, and a rush of water flooded the bore-hole; unfortunately this water was so impregnated with salt and with gypsum as to be unfit for domestic purposes.

About eight or ten years ago the Birmingham Corporation put down a bore-hole in Small Heath Park (a southern suburb of Birmingham), in search of water for certain baths and wash-houses which it was proposed to build there. A depth of 440 feet was attained, entirely in the Keuper Red Marls, before the boring was abandoned. I have seen numerous specimens of fibrous gypsum obtained from varying depths in this bore-hole.

Early in the present year Messrs. Bates, of the King's Heath Brewery, three miles south of Birmingham, resolved to make a deep boring for water through the Red Marls on which their buildings stand, at a distance two miles to the east (down-throw side) of the line of fault already described. They entrusted the work to Messrs. Le Grand and Sutcliffe, of 100, Bunhill Row, London, who have successfully carried out similar undertakings in many parts of the country. The work has been rapidly carried forward, and the latest statement of results is as follows:—

| Contractor's Notes. | Depth in Feet. | Geological Notes. | Feet. |
|---|---|---|---|
| Dug well... ... ... ... | 32 | Post-glacial Sands ... ... ... | 36 |
| Red Sand ... ... ... ... | 4 | | |
| Red Marl and Pebbles ... ... | 8 | Boulder Clay ... ... ... ... | 20 |
| Rough Ballast ... ... ... | 12 | | |
| Red Marl ... ... ... ... | 158 | Keuper Marls ... ... ... ... | 611 |
| Red Marl and Gypsum ... ... | 131 | | |
| Marl, Shale, and Gypsum ... | 309 | | |
| Marl and Shale ... ... ... | 3½ | | |
| Red Stone and Shale ... ... | 9½ | | |
| Total depth reached ... | 667 | | 667 |

There is no thick bed of gypsum, but this mineral occurs per-

[1] Warwickshire Coalfield, Survey Memoir, 1859, pp. 41–44.
[2] South Staffordshire Coalfield, Survey Memoir, 1859, p. 4.

sistently in streaks and fibrous deposits throughout the greater part of the strata. Many of the cores of marl brought up are remarkably hard, affording a great contrast to the ordinarily soft and crumbling nature of the strata as we usually see them in a weathered condition in brick-pits, etc.

It is possible that the "red stone and shale"—a hard sandy marl—which forms the bottom bed now reached, marks the incoming of the Lower Keuper Sandstone. Similar strata were found at the bottom of the Lindley Hall boring. Certainly the depth already reached—667 feet—is the point at which our previous knowledge would lead us to expect the change to occur. For although the first 56 feet is occupied by surface-deposits, leaving 611 feet for the Red Marls, yet it must be remembered that we are only two miles east of the fault, and that the upper portion of the Marls—to what extent we cannot precisely tell—must have been removed by denudation.

Just as the boring has reached this most interesting point, an unfortunate accident has temporarily delayed its progress. A tool has broken in the very bottom of the boring, and the removal of the broken piece is a difficult operation. But doubtless this obstacle will quickly be overcome. As to the quality of the water to be obtained from the Keuper Sandstones, the promoters of the boring doubtless hope that it will be similar to that at Burton, where the presence of a moderate amount of gypsum in the water from deep wells sunk through the Red Marls is found to be of great value in brewing operations.

The action of a fault when it brings a thick bed of impervious material like clay or marl side by side with a porous sandy stratum—the sandy beds dipping towards the line of fault—is strikingly shown both at Birmingham and Stourbridge. In Birmingham there is any quantity of water to be had from the Sandstones and Pebble Beds right up to the line of fault. The artesian well, about 200 feet deep, in Digbeth, must be within a few yards of the fault-line, and the water obtained is used in the manufacture of mineral waters, and is so highly prized that it may frequently be seen conveyed in a large barrel on wheels to various establishments in the town.

At Stourbridge exactly the same thing happens. A north and south fault brings Permian Marls on a level with the Bunter Pebble Beds and Keuper Sandstones, the latter dipping towards the Marls. The water is banked up by the Marls and yields an unlimited supply to the wells of the Stourbridge Water Company, which lie just on the right (west) side of the line of fault.

The railway company occupies the land on the marly side of the fault, and in years gone by they sank well after well in the marls in vain search for water, and the officials were much chagrined and surprised at its absence, seeing that any quantity of the precious fluid was being pumped up within a few yards of their land!

## VI.—On Palæozoic Phyllopoda.

By Prof. T. Rupert Jones, F.R.S., F.G.S.[1]

SINCE the publication of the Third Report on Palæozoic Phyllopoda (Brit. Assoc. Report for 1885), we have examined many additional specimens in the Museums of the Edinburgh and Glasgow Universities, and in the Braidwood Museum belonging to Dr. J. R. S. Hunter, of Braidwood, near Glasgow. Mr. James Thomson, F.G.S., has given us a quantity of nodules, containing remains of *Ceratiocaris*, from the Lesmahago district; and other friends have lent us several interesting specimens.

We have also again critically examined the fossils enumerated under *Ceratiocaris*, in the Third Report, and, having had numerous finished drawings carefully made for illustration of a forthcoming monograph for the Palæontographical Society, we have been able to compare them more perfectly and with more precise results.

Thus we find that—

1. *Ceratiocaris leptodactylus* (M'Coy), see Third Rep. pp. 11–14, as known by its caudal appendages (Cambr. Mus. *a*/923, *a*/924, and a few others), is distinct from *C. Murchisoni*, M'Coy, both as to size and proportions. We have traced two rows of pits (bases of prickles) on *a*/924, as exposed. Some similar caudal appendages, M.P.G. $\frac{1}{14}$, occur in the Lower Wenlock rock of Helm Knot, Dent, Yorkshire.

2. *C. Murchisoni* (Agass.), founded on some specimens figured in Sil. Syst. and Siluria, but unfortunately lost (Third Rep. p. 11, etc.), is represented by several analogous fossils, such as Oxford Mus. B and C; Ludlow Mus. C; M.P.G. $\frac{2\,3}{3\,3}$ and $\frac{2\,3}{3\,6}$. We find only one row of pits on the styles, as exposed. We have been unable to determine its carapace; but a fragment lying in the same slab with $\frac{2\,3}{3\,6}$ may belong to it. The carapaces formerly assigned to *C. leptodactylus* and *C. Murchisoni* (Third Rep. pp. 12, 15) are now regarded as belonging to distinct species.

3. The caudal appendages of *C. Murchisoni* have a slight curvature; there are others much like them, but straight, and associated with a large ultimate segment, much broader than that in M.P.G. $\frac{2\,3}{3\,6}$. (For instance, Oxford Mus. F; M.P.G. X $\frac{1}{2}$; Ludlow Mus. T.) One of these (X $\frac{1}{2}$) has been labelled *C. gigas* by Mr. Salter; and therefore we adopt that name.

4. The specimens from the Wenlock beds of Dudley and Kirkby Lonsdale, described and figured in the Geol. Mag. 1866, p. 204, Pl. X. Figs. 8 and 9, as belonging to *C. Murchisoni* (Third Rep. p. 12), are too thick and strong for that species, and the Dudley example (Fig. 8) has different proportions. We propose to distinguish them as *C. valida*.

5. Some abdominal segments (Oxford Mus. E; Ludlow Mus. L; B.M. 39403; M.P.G. $\frac{2\,3}{3\,5}$ and $\frac{2\,3}{3\,6}$; Third Rep. p. 20, etc.), narrow in

[1] Being the substance of the Fourth Report of a Committee consisting of Messrs. R. Etheridge, F.R.S., H. Woodward, LL.D., F.R.S., and Prof. T. Rupert Jones, F.R.S. (*Secretary*), on the Fossil Phyllopoda of the Palæozoic Rocks, read before Section C. British Association, Birmingham, Sept. 8, 1886.

proportion to those in other specimens marked $\frac{2}{3}\frac{3}{5}$, and referred to *C. Murchisoni*, and very much narrower and smaller than in *C. gigas*, we separate as a new species, to be called *C. attenuata*. They have straight styles and stylets, very much shorter than in either of the foregoing.

6. Two small specimens of crushed telsons (one in Mr. Cocking's collection, and the other M.P.G. X $\frac{1}{2}\frac{1}{8}$, both from the Ludlow series), probably smaller than *C. Murchisoni*, have a fluted or channelled sculpture on their upper part, instead of either wrinkles or leaf-pattern; hence they may be regarded as belonging to a distinct form, for which the name *canaliculata* will be convenient.

7. One fine large carapace (M.P.G. X $\frac{1}{2}$) and others smaller and less definite in some respects (M.P.G. X $\frac{1}{3}$; X $\frac{1}{6}$; X $\frac{1}{9}$: Ludlow Mus. A; Oxford Mus. K and J), and associated with segments and appendages, we regard as distinctive of a new species, though hitherto referred to *C. leptodactylus* (Third Rep. pp. 12, 15). The test appears to have been of an unusually solid consistency.

These carapaces in some instances have been much modified by pressure, but we trace a close similarity throughout the series, allowing for probable differences of age. The shape approximates to that of Dr. James Hall's species *C. acuminata* and F. Schmidt's *C. Noetlingi* (Third Rep. p. 30). There are marked differences, however, and we intend to designate this form *C. Halliana*, in honour of our old friend, who began working at these Phyllocarida as early as 1852.

A perfect specimen of *C. acuminata*, Hall, has been lately described and figured by Dr. Julius Pohlman in the Bulletin of the Buffalo Society of Natural Sciences, vol. v. No. 1, 1886, pp. 28, 29. pl. 3, fig. 2. Its caudal appendages are much like those of *C. papilio* and *C. stygia*, the style being relatively short, and the stylets broad and blade-like. The appendages in M.P.G. X $\frac{1}{7}$, X $\frac{1}{9}$, and Ludlow Mus. A are different from these, being thinner, tapering slowly, and pitted in at least one row, as exposed.

8. *C. Pardoeana*, La Touche. Two carapaces with segments and parts of appendages from Ludlow (Ludlow Mus. B and D; Third Rep. p. 12) differ from any other form. One of them (B), with a wrong caudal appendage attached to it, in the Ludlow Museum, has been labelled '*C. Pardoensis*,' and as such is referred to in J. D. La Touche's Guidebook to the Geology of Shropshire. We retain this name (altering the termination, as it refers to a person, and not a place) for the two carapaces here referred to. One of them (B) is of special interest as having its *rostrum* still in place.

9. The fine large specimen of *C. ludensis*, H. W. (Third Report, p. 16), has been again carefully studied, and we find reason to believe that the caudal appendage which appears longest in the fossil was not really the longest, or the true telson, but was one of the 'laterals' or stylets. Hence the whole animal was probably much longer than our former estimate made it.

10. *C. robusta*, Salter (Third Report, p. 24), being based merely on some small caudal appendages (Cambridge Museum *a*/925 and

*a*/926) without carapaces, is troublesome and unsatisfactory to deal with. We find some equivalent styles and broad blade-like stylets, like long scalene triangles, in *C. papilio, stygia, acuminata*, etc.; but none of these seem small enough for the several little sets of trifid appendages, more or less perfect, which we have met with. *C. robusta* takes in some of these; but Oxford Mus. T is relatively broad, and might be termed *lata*; B.M. 58878, from Muirkirk, has very narrow members (*angusta*); and one set in the Owens College is so neat, symmetrical, and small that it might be called *minuta*.

11. The specimens Ludlow Mus. S. and M.P.G. $X\frac{1}{1\cdot7}^2$ have each a long style and a strong stylet attached to a broken ultimate segment, and were regarded as var. *longa* in the Third Report, p. 25. Although not showing the lattice-pattern so often seen on the segments of *C. papilio* and *C. stygia*, they may well belong to one of those species, and the ornament may have flaked off from the ultimate segment. The study of *C. papilio* and *stygia* (Third Report, pp. 16–20) we have not yet exhausted by any means. We know, however, that the abdominal segments were delicately sculptured with leaf-like or lattice-pattern ornament, the points of the triangles pointing upwards, or rather backwards, towards the carapace, and one limb of the triangle, where free, running downwards and outwards in the other direction. These oblique lines are often visible when the triangles have disappeared from wear or decomposition. Among many others the segments M.P.G. $X\frac{1}{1\cdot7}\frac{1}{1}$; B.M. 41900; Oxford Mus. A and H exhibit fine examples of this leaf-like ornament; and it is visible in several more complete individuals in those collections. In the Braidwood and Glasgow Museums numerous specimens show it well. See also Third Report, p. 31.

12. A small and very delicate specimen, B.M. 59648, has a thin subovate carapace, with excessively fine parallel longitudinal striæ, and shows 14 or 15 segments, some within and five outside the carapace, ending with a neat trifid set of appendages. This differs from any other form we know; and probably some small loose bodies, of numerous segments, occurring in the Lesmahago shales (Third Report, p. 20) may be of the same species. Its looseness of structure would suggest the name *laxa*.

13. Of *C. Salteriana*, noticed as a new species in the Third Report, p. 23, we have not yet seen any additional specimens.

14. The specimens which we referred to in the Third Report pp. 23 and 24, as *C. cassia*, Salter, are separable into two forms. *C. cassia* proper is recognized on an interesting slab, of which one counterpart is in the Ludlow Museum (E and F) and the other in the Museum of Practical Geology at Jermyn Street, London ($X\frac{1}{1}$). The other, somewhat similar, but larger and otherwise different, specimens are not unlike in the characters of the carapace, but they have more abdominal segments exposed and proportionally longer caudal appendages—M.P.G. $X\frac{1}{2\cdot6}$; B.M. 39400; Ludlow Mus. K; Oxford Museum L and Q. These might be conveniently named *C. cassioides*.

In all the specimens of both kinds the carapace has been ap-

parently thin and tough, so as to allow of their being crumpled very much. This condition and the presence of harder parts of their internal organs beneath give rise to various tubercular irregularities of the surface, in some cases simulating ocular tubercles. There are, however, no real eye-spots. There may have been irregularities of the surface, due to the attachment of the muscles of the jaws within the body.

15. An ovate carapace, represented by a mere film, and five abdominal segments, with a neat trifid tail, all flattened but very distinct, have no close ally among the known forms. The segments are delicately striate, with oblique lines on each side, suggesting the name *compta*, which we propose for this specimen—Ludlow Museum E.

16. To *C. inornata*, M'Coy (Third Report, pp. 20, 21), we have nothing to add, except that some large specimens (so named, Cambridge Mus. *b*/35) have a greater proportional depth (height) at the ventral border than smaller individuals, and yet have the same general outline and posterior slope, as well as the longitudinal lineate ornament. (The presence of this sculpturing is not in accordance with the trivial name.) These large specimens may belong to *C. stygia*.

In the Cambridge Museum is a specimen (*b*/36) of two abdominal segments, with a style and a stylet in good preservation, being convex and not injured by pressure. The penultimate segment is smooth, but shows faint traces of oblique lines; the ultimate is quite smooth and cylindrical; the telson (style) is attached by an apparently rounded joint; and the two uropods much resemble some of those referred to *C. robusta*. This specimen is from Benson Knot, and is labelled *C. inornata*; but the evidence of its specific relationship is supported only by its having been found in the same rock, and by its size suiting the large form of *C. inornata*? (*b*/35). It belongs possibly to *C. stygia*.

17. From the list for *C. inornata*, given in the Third Report, we have to remove one of the specimens found at Benson Knot, and marked '44342' in the British Museum, being decidedly different in outline (more ovate), though similarly marked with longitudinal striæ. It might well be named *C. Ruthveniana*, in memory of the old geological collector who laboured for very many years in the Kendal district for Professor Sedgwick and others.

18. *C. oretonensis* and *truncata*, H.W. (Third Report, pp. 21, 22), though near to *C. inornata* in shape, hold their distinct places as species.

19. Of *C. solenoides* and *C. gobiiformis* (Third Report, p. 22) there is nothing new to be stated.

20. As intimated in the Third Report, pp. 27, 28, the presence of the ocular tubercle has an important signification, showing that the animal must have had an organ equivalent to the eye sufficiently developed to affect the external covering, whether it was adapted for clear vision or not. It may be a family distinction; at all events, the oculate carapaces have to be removed from *Ceratiocaris* and we

propose that M'Coy's *C. elliptica* be referred to a new genus under the name *Emmelezoe*.[1]

*E. elliptica*, M'Coy, is described in the Third Report, p. 27, as represented by the type, Cambridge Mus. *b*/15; but Ludlow Mus. G, and M.P.G. $X\frac{1}{1\,0}$ and $\frac{2\,3}{3\,2}$ differ from it considerably. The first of these is shorter and broader (higher), nearly semicircular in outline, with an acute and projecting postero-dorsal angle; and its surface has a fine, almost silky, linear ornament. As a new species this might be known as *E. tenuistriata*. The specimen $X\frac{1}{1\,0}$ is subovate, larger than either of the other two, and is coarsely striate, with longitudinal anastomosing wrinklets and might be named *E. crassistriata*. M.P.G. $\frac{2\,3}{3\,2}$ is smaller than any of the foregoing, somewhat boat-shaped, between the last and *elliptica* in shape, but not identical with either; and it is rather coarsely striate longitudinally. To this form we propose to give the name *E. Maccoyiana*, in honour of the first describer of any member of this genus.

21. At page 26 of the Third Report, we described Salter's *Ceratiocaris? ensis*, and now we are still more confirmed in the opinion that it belonged to a distinct genus. Its large size, its curvature, and the serration on both the upper and the lower edge, and the profuse spination (as shown by pits) on the latter distinguish it from other telsons; and more particularly its lozenge-shaped sectional area, of an unequal rhombic form, blunter at the outer (upper) and convex edge than on the other, the ridge along the sides not being quite on the medial line, but nearer the outer than the inner edge. We propose the name *Xiphocaris*[2] for this rare genus.

M. Barrande's *Ceratiocaris primula* (Third Report, p. 32) has a style (or stylet?) with lozenge- or diamond-shaped section; but this uropod, though curved, is of different dimensions, and is pitted all over.

22. *Physocaris vesica*, Salter (Third Report, p. 28) we consider as having had its abdominal segments shifted from below upwards, and turned over on their axis, after death; and therefore as having been figured upside down.

23. Of *C.? lata*, *insperata*, and *perornata* we have no further evidence at present.

24. *Ceratiocaris? longicauda*, D. Sharpe (Third Report, p. 29), a foreign (Portuguese) form within our reach has been studied in the Geological Society's Museum, Burlington House, and shows some interesting features. Its scientific name was given under the supposition that the fossil was a *Dithyrocaris*, with a longer abdomen than usual; but its cylindrical ultimate segment, its somewhat bayonet-shaped style, and blade-like stylets clearly remove it from that genus, as intimated in our former notice. It is probably distinct also from *Ceratiocaris;* it has some analogy with the Devonian *Elymocaris;* but at present we cannot fix its generic place.

25. In the Sitzungsb. K. böhm. Ges. Wiss. 1885, M. Ottamar Novák, Keeper of the Barrande Collection at Prague, has described

[1] Ἐμμελής, elegant; ζωή, life (a termination common in some of M. Barrande's genera).

[2] Ξίφος, a sword; καρίς, a shrimp.

a new Phyllocaridal genus from the *étage* F, f 2, in Bohemia, as *Ptychocaris*, with two species *Pt. simplex* and *Pt. parvula*, characterized by a strong and obliquely longitudinal ridge or sharp fold on each valve, and by an anterior group of three small nodules, an ocular tubercle behind them, and some larger but less distinct

| Species of Ceratiocaris, Physocaris, Xiphocaris, and Emmelezoe. | Carboniferous Limestone; Oreton. | Ludlow Beds. | | | | | Wenlock Beds. | | | Upper Llandovery; Onny River. | Tremadoc Slates; Portmadoc. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Upper Ludlow; Ludlow. | Upper Ludlow; Benson Knot, Kendal. | Upper Ludlow; Lesmahago and Muirkirk. | Lower Ludlow; at and near Ludlow. | Upper Shale = Lower Ludlow. Dudley. | Lower Shale = Wenlock. | Wenlock; Kirkby-Lonsdale. | Lower Wenlock; Helm Knot, Dent. | | |
| 1. *Ceratiocaris leptodactylus* | — | — | — | — | × | — | — | — | × | | |
| 2. *C. Murchisoni* | — | × | — | — | × | | | | | | |
| 3. *C. gigas* | — | — | — | — | × and Knighton. | | | | | | |
| 4. *C. valida* | — | — | — | — | — | — | × | × | | | |
| 5. *C. attenuata* | — | — | — | — | × | | | | | | |
| 6. *C. canaliculata* | — | × | | | | | | | | | |
| 7. *C. Halliana* | — | — | — | — | × | | | | | | |
| 8. *C. Pardoeana* | — | — | — | — | × | | | | | | |
| 9. *C. ludensis* | — | — | — | — | × | | | | | | |
| 10. *C. robusta* | — | × | — | — | × | | | | | | |
| 11. *C. lata* | — | — | — | — | × | | | | | | |
| 12. *C. angusta* | — | — | — | × | | | | | | | |
| 13. *C. minuta* | — | — | — | — | × | | | | | | |
| 14. *C. papilio* | — | — | ? | × | × | | | | | | |
| 15. *C. stygia* | — | — | ? | × | | | | | | | |
| 16. *C. laxa* | — | — | — | × | | | | | | | |
| 17. *C. Salteriana* | — | — | — | — | × | × | | | | | |
| 18. *C. cassia* | — | — | — | — | × | | | | | | |
| 19. *C. cassioides* | — | — | — | — | × | | | | | | |
| 20. *C. compta* | — | — | — | — | × | | | | | | |
| 21. *C. decora* | — | — | — | — | Freshwater Pembrokeshire. | | | | | | |
| 22. *C. oretonensis* | × | | | | | | | | | | |
| 23. *C. truncata* | × | | | | | | | | | | |
| 24. *C. inornata* | — | — | × | | | | | | | | |
| 25. *C. Ruthveniana* | — | — | × | | | | | | | | |
| 26. *C. solenoides* | — | — | × | | | | | | | | |
| 27. *C. gobiiformis* | — | — | × | | | | | | | | |
| 28. *C. perornata* | — | — | × | | | | | | | | |
| 29. *C. ? lata* | — | — | — | — | — | — | — | — | — | — | × |
| 30. *C. ? insperata* | — | — | — | — | — | — | — | — | — | — | × |
| 31. *C. ?* sp. | — | — | — | — | — | — | — | — | — | × | |
| 32. *Physocaris vesica* | — | — | — | — | × | | | | | | |
| 33. *Xiphocaris ensis* | — | — | — | — | × | | | | | | |
| 34. *Emmelezoe elliptica* | — | — | × | | | | | | | | |
| 35. *E. tenuistriata* | — | — | — | — | × | | | | | | |
| 36. *E. crassistriata* | — | Presteign | | | | | | | | | |
| 37. *E. Maccoyiana* | — | — | — | — | × | | | | | | |

swellings further back, but still in the antero-dorsal region. M. Novák supplies also a table of the vertical distribution of the *Phyllocarida* in Bohemia.

In the Annales XIII. Soc. Géol. du Nord, 3me Livr. April, 1886, p. 146, M. E. Canu gives a *résumé* of the results of M. O. Novák's researches in the *Phyllocarida*, with some woodcuts of *Aristozoe regina*, *Bactropus longipes*, and *Ceratiocaris debilis* (see Third Report, pp. 32–34), and of *Ptychocaris simplex* (see above).

26. Dr. A. S. Packard, jun., has described and figured some peculiar appearances on an internal cast of a Carboniferous Phyllopodous carapace from Illinois, as traces of four pairs of lamellate limbs (thoracic feet), probably "the homologues of the exopodites of *Nebalia*." He has defined the genus and species as *Cryptozoe problematica* (American Naturalist, Extra, Feb. 1886, p. 156; and Proceed. Americ. Philosoph. Soc. vol. xxiii. No. 123, pp. 380–383).

27. In a Geological Report, Assembly Document, No. 161, 1885 (or 1886), Mr. J. M. Clarke has defined the localities and geological succession in Ontario County and New York, where the Phyllopods which he previously described (see 'Second Report,' 1884, pp. 80–86, and 'Third Report,' p. 3) have occurred with or without Goniatites.

28. A list of the British Palæozoic Phyllocarida described in the Third and Fourth Reports is given on the preceding page (p. 461).

## NOTICES OF MEMOIRS.

I.—Records of the Geological Survey of India, vol. xix. pt. 2. 1886.

TWO short papers in this part relate to the disputed age of the beds in the Salt Range, containing species of *Conularia*. The first is "A Note on the Olive Group of the Salt-range," by R. D. Oldham, A.R.S.M., and the other "Memorandum on the Discussion regarding the Boulder-beds of the Salt-range," by H. B. Medlicott, F.R.S. Mr. Oldham visited the locality in the Salt-range, in which the *Conularia* beds occur, and states that the thin band of gravel in which they appear is the last kind of rock in which one would *à priori* expect concretionary nodules to be formed. At the same time he believes that for the most part these fossiliferous pebbles were originally concretionary nodules, and that they have been transported into their present position. From the character of the associated pebbles in the beds beneath, he believes that the original position of the beds from which the *Conularias* come must have been to the southward of where they now are. He further concludes from the stratigraphical relations of the beds, that the Olive group (including the gravel-bed with *Conularia*) is homogeneous, and must be associated with the overlying nummulitic beds, rather than with the underlying Palæozoic or early Secondary beds.

Mr. Medlicott does not admit that the petrological evidence brought forward by Mr. Oldham is altogether conclusive as to the transported origin of the fossiliferous pebbles, though it would be "almost absolute if he could assert that the ground-mass of the gravel-bed is quite

different from that of the fossiliferous pebbles in the bed." Further, even supposing the correctness of Mr. Oldham's theory, that the fossiliferous pebbles are concretionary nodules, it does not at all explain the presence of this small special fauna in a distinct bed by itself. Mr. Medlicott asks the following pertinent question: "Is it conceivable that in Upper Cretaceous time, when the abundantly fossiliferous Permian and Secondary deposits were in force in the neighbourhood, and presumably exposed to denudation, if older deposits were so, a special collection of fossils from those older fossils can have been raked together, transported together, and deposited together at a distance, by the promiscuous process of detrital agency?" "So long as special Palæozoic fossils only are found in these beds, their Upper Cretaceous age will be open to doubt."

This argument has great force; and evidence of a more decided character will be required, before the relative age of the *Conularia* beds, and the boulder-beds underlying them, can be regarded as settled. G. J. H.

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II.—Memoirs of the Geological Survey of India. Palæontologica Indica. Ser. xiii. Salt Range Fossils, by William Waagen, Ph.D., F.G.S., and Joseph Pichl. I. Productus-Limestone Fossils: 5. Bryozoa—Annelida—Echinodermata. With ten plates, 87—96.

THE authors reject from the Bryozoa, and regard as Corals, such forms as *Stenopora*, *Monticulipora*, and allied genera. The Bryozoa described belong to the families of the Fenestellidæ and Thamniscidæ. In the first of these families the following species are recorded: *Fenestella perelegans*, Meek, *F. jabiensis*, n., *Polypora Koninckiana*, n., *P. megastoma*, Kon. sp., *P. gigantea*, n., *P. ornata*, n., *P. sykesi*, Kon. sp., *P. biarmica*, Keyser, *P. vermicularis*, n., *P. transiens*, n., *Phyllopora jabiensis*, n., *P. cribellum*, Kon., *P. haimeana*, Kon., *Synocladia virgulacea*, Phill., *Goniocladia indica*, n. In the family Thamniscidæ are ranged *Thamniscus dubius*, Schlot., *T. serialis*, n., and *Acanthocladia anceps*, Schlot. In the Annelidæ, *Spirorbis helix*, King, and *Serpulites indicus*, n., are described. Fragmentary plates and species of *Eocidaris Forbesiana*, Kon., are noted. The following species of Crinoids are present: *Cyathocrinus goliathus*, n., *C. virgulensis*, n., *C. indicus*, n., *C. Rattaensis*, *Hydriocrinus*? sp. indt., *Poteriocrinus*, sp. indt., and *Philocrinus cometa*, Kon. The descriptions of these species are very carefully and fully drawn up, and they are excellently illustrated in the accompanying plates. G.J.H.

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III.—Notice sur le Parallélisme entre le calcaire Carbonifère du nord-ouest de l'Angleterre et celui de la Belgique; par L. G. de Koninck et Maximin Lohest. (Bruxelles, Bulletins de l'Académie royale de Belgique, 3me série, t. xi. No. 6, 1886.)

ONE of the authors has lately examined the horizontal beds of conglomerate of white quartz pebbles in a calcareous matrix, which, in the neighbourhood of Ingleborough, rest unconformably on Silurian strata, and form there the base of the Carboniferous

system. The fossils in these beds comprise, amongst others, *Lithostrotion basaltiforme*, species of *Amplexus* and *Zaphrentis*, and teeth of Placoids, some of which are recognized as *Lophodus lævissimus*, Ag., and *Copodus cornutus*, Ag. Resting on the conglomerates are grey limestones with an abundance of *Chonetes papilionacea*, Phill. In these, and the beds below, *Productus giganteus* is conspicuously absent, whilst it is extremely abundant in the limestone beds of the series above. In the Belgian Carboniferous Limestone series there are no conglomerates like those at Ingleborough, but at the base of the limestones with *Productus giganteus* and *P. cora*, forming the 'Calcaire de Visé,' there are some beds distinguished by the abundance of *Chonetes papilionacea*, and between these and the Upper Devonian strata there is a great thickness of beds containing Corals and Placoid teeth, analogous to those in the Ingleborough Conglomerates, and the authors therefore conclude, that these Lower Limestones, beneath the Calcaire de Visé, are represented in part by the Yorkshire Conglomerates, which are not more than about 180 feet in thickness. On the other hand, the zone of *Productus giganteus* in the north of Yorkshire attains a much greater thickness than in Belgium.

G. J. H.

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IV.—Fifth Annual Report of the United States Geological Survey, 1883–84. By J. W. Powell, Director. 4to. pp. 469, 58 Plates and 143 Figures. (Washington, Government Printing Office, 1885.)

At the beginning of this massive volume the Director of the Survey gives an epitome of the work carried out, together with the financial statement, from which it appears that the year's expenditure for the Survey amounted to nearly 330,000 dollars, or about £67,300. This is followed by brief administrative reports of chiefs of divisions and heads of independent parties, from which an idea may be formed of the extent and variety of the operations included in the Survey. Thus, the chief geographer, Mr. Henry Gannett, reports that topographical field work had been actively carried on by different parties in Northern California, Arizona, New Mexico, Montana, the Yellowstone Park, Massachusetts, the Denver District of Colorado, and part of the Elk Mountains. The party under the charge of Mr. Arnold Hague was engaged in working out the geology of the Yellowstone National Park, and studying the physics of geyser action in that district. Mr. T. C. Chamberlain reports on the investigations made by himself and others under him in tracing out the moraines and other glacial deposits in the upper valleys of the Mississippi and Missouri, in Dakota, and also in Illinois, Indiana, Ohio, and Kentucky. The division under Prof. Roland D. Irving is engaged in a general investigation of the Archæan formations of the North-western States, and its field of operations extended from Northern Michigan to the country on the north-west of Lake Superior. Dr. F. V. Hayden studied the relations of the Laramie Group and other Cretaceous rocks, exposed between the Missouri at Bismark, Dakota, and the Yellowstone at Glendive, Montana. Mr. G. K. Gilbert and his assistants carried on their

work of investigating the Quaternary Lakes of the Great Basin in Utah and California. Mr. W. J. M'Gee reports on the progress made in preparing a general geological map of the United States, as well as on his studies of the superficial deposits of the district of Columbia and adjacent territory. Captain C. E. Dutton is engaged in studying the chain of volcanoes constituting the Cascade Range in California, Oregon, and Washington Territory. Mr. S. F. Emmons reports on mining geology of the Rocky Mountains, and Mr. G. T. Becker on the quicksilver mining district of Knoxville in California. Prof. O. C. Marsh states that eight different parties were engaged in collecting fossils in Oregon, Wyoming, Kansas, and Nebraska, and that his monographs on the *Sauropoda* and the *Stegosauria* were in course of completion. Dr. C. A. White was engaged in studying the Laramie Group on the Upper Missouri, and on various palæontological investigations in Washington and California. Mr. C. D. Walcott, assisted by Prof. H. S. Williams and others, has studied the Devonian and other Palæozoic rocks of New York, Tennessee, Virginia, Vermont and Alabama. Mr. Lester F. Ward has been collecting and arranging the fossil plants of the Fort Union Group on the Yellowstone and Upper Missouri rivers. The chemical work of the Survey is directed by Mr. F. W. Clarke, whilst Mr. A. Williams is engaged on the statistics of metals; and, finally, Mr. G. W. Shutt traces the course of a preliminary geological investigation in Virginia.

These administrative reports, however, only occupy sixty-six pages of the volume; the remaining 400 pages contain a series of elaborate essays on different branches of geological science, each of which is treated in considerable detail, and abundantly and beautifully illustrated. We can here but mention the titles of the different treatises and the authors' names, and refer the reader to the volume itself. The first treatise is on "The Topographic Features of Lake Shores," by G. K. Gilbert. This is followed by "The Requisite and Qualifying Conditions of Artesian Wells," by T. C. Chamberlain; "Preliminary Paper on an Investigation of the Archæan Formations of the North-Western States," by R. D. Irving; "The Gigantic Mammals of the Order Dinocerata," by Prof. O. C. Marsh; "Existing Glaciers of the United States," by T. C. Russell; and "Sketch of Palæobotany," by Lester F. Ward. G. J. H.

## REVIEWS.

DEPARTMENT OF THE INTERIOR. REPORT OF THE UNITED STATES GEOLOGICAL SURVEY OF THE TERRITORIES. F. V. HAYDEN, UNITED STATES GEOLOGIST-IN-CHARGE. VOLUME III. THE VERTEBRATA OF THE TERTIARY FORMATIONS OF THE WEST. BOOK I. By EDWARD D. COPE, Member of the National Academy of Sciences. (Washington, Government Printing Office, 1883.)

(*Continued from p.* 419.)

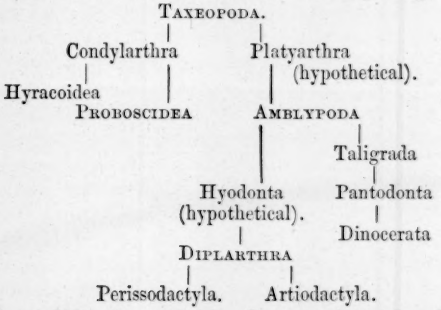
BATS are scantily represented in the Bridger fauna, the only American species described by Professor Cope being *Vesperugo anemophilus*, which has the inferior molars like those of *Didelphys*.

We now turn to the group division of hoofed mammals. The first order, which the author names TAXEOPODA, comprises animals, in which the carpus and tarsus form two rows, with the bones of the first row supported by the second row, each for each, so as not to alternate. The order is defined as having the scaphoid bone supported by the trapezoid, and the lunar bone supported by the magnum. The cuboid bone articulates proximally only with the calcaneum. This group comprises the HYRACOIDEA, in which the fibula articulates with the astragalus, and the ungual phalanges are truncate; secondly, the CONDYLARTHRA, in which the fibula does not articulate with the astragalus or calcaneum, and the ungual phalanges are pointed. A third group may be formed by the TOXODONTIA, or the Toxodontia may belong to the Proboscidea.

The AMBLYPODA is an order which is subdivided into two groups, first, *Pantodonta*, which has a third trochanter to the femur, and incisor teeth in the upper jaw; and secondly, *Dinocerata*, which has no upper incisors, and no third trochanter. The Amblypoda are defined from the Proboscidea, chiefly by the shortness of the navicular bone, which allows the cuboid bone to articulate with the astragalus.

The name DIPLARTHRA is used as an ordinal name for the Perissodactyla and Artiodactyla, in place of the name Ungulata, which is made to include all hoofed mammals.

This classification is exhibited in the following diagram:—

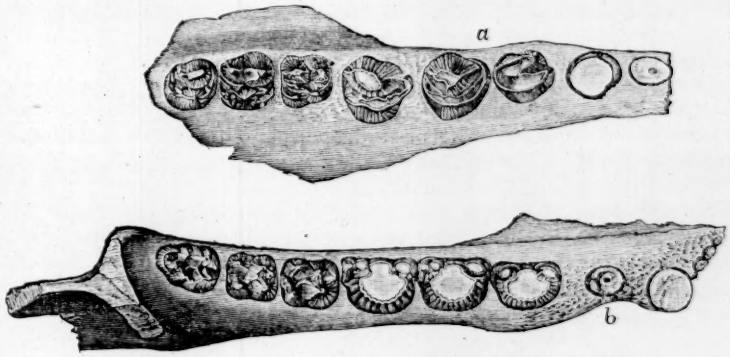



The carpal modification which characterizes the Diplarthra is explained as a rotation of the bones of the second carpal row upon those of the first row, in which they move to the inner side, a condition attributable to the loss of the pollex, by which the weight of the body is thrown chiefly on the third and fourth digits. And seeing that this condition has brought about the alternation of the two rows of carpal bones, producing a stronger carpus, the author is disposed to regard the modification as accounting for the survival of the Diplarthra, while most of the mammals which have a serial arrangement of the carpal bones have become extinct.

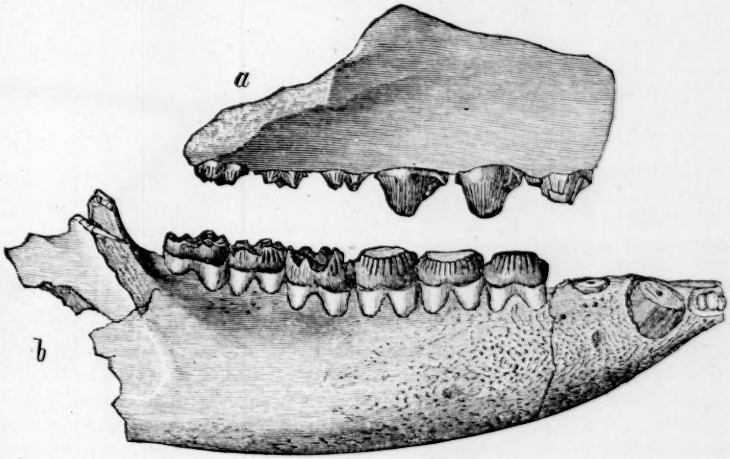
The Amblypoda is intermediate between the Taxeopoda and Diplarthra, in having the carpus of the more complicated type. The Taxeopoda approach most nearly to the Bunotheria, especially the Mesodonta, from which they are distinguished by their hoofs,

though some Creodonts like *Mesonyx* have claws which are almost hoofs in character.

The Condylarthra comprise three families; they are primitive ungulates, with five-toed, plantigrade feet, with the astragalus like that of the Creodonta and Carnivora, and have other characters known only among Unguiculates. The lowest representative of this group is the Periptychidæ. It comprises four genera. In *Periptychus* the inferior premolar teeth have internal lobes, while in the other genera, *Anisonchus, Hemithlæus,* and *Haploconus,* the internal lobes are wanting. The crowns of the true molars have seven tubercles; the canines are of moderate size, and the inferior incisors small.




Upper Jaw (*a*). Mandible (*b*). *Periptychus rhabdodon.*

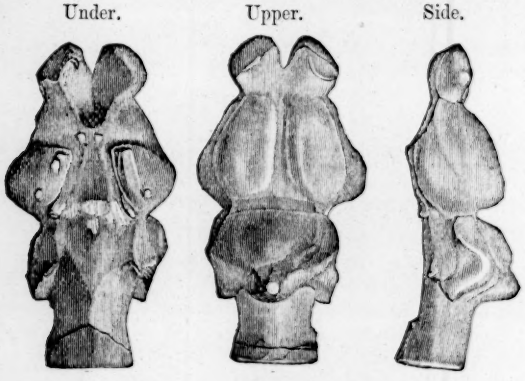



*Periptychus rhabdodon.*

The true molars in the mandible have four principal cusps, in opposite pairs, with accessory median cusps in front and behind. The angle of the lower jaw is not inflected, and the coronoid process

rises near to the condyle. The cerebral hemispheres are long and narrow, divided by a long flat crus from the olfactory lobes, which are nearly as wide as the cerebral hemispheres. The affinities of this type are not, however, regarded as absolutely determined. The premolar teeth have a sculpture which is not unlike that seen in the fourth premolar of *Ptilodus*, yet there are no other reasons for supposing it to be marsupial. The characters of the astragalus are not unlike those seen in the Creodonta, but other structures indicate that it was probably ungulate. Three species are known, among which *P. rhabdodon* is fully described. Its cervical vertebræ are as short as in the Elephant. The humerus especially, in its small tuberosities, suggests the Proboscidea, though the animal was only about the size of the Collared Peccary, and is thought to have had much the aspect of the short-necked Bear. The teeth indicate omnivorous habit. It is the most abundant Mammal of the Puerco beds. Many of the other types in this family like the species of *Hemithlœus*, *Anisonchus*, and *Haploconus*, are known from little more than the dentition, which varies in the number and form of the cusps of the upper molar and premolar teeth.

The Phenacodontidæ is an allied group of four genera, in which the teeth have much the same general plan as that just described. *Protogonia* has but one external lobe in the upper premolar teeth. In *Phenacodus* the fourth premolar has two external lobes, while in *Diacodexis* the two external lobes are found in the second, third, and fourth teeth.




Brain of *Phenacodus primævus*.

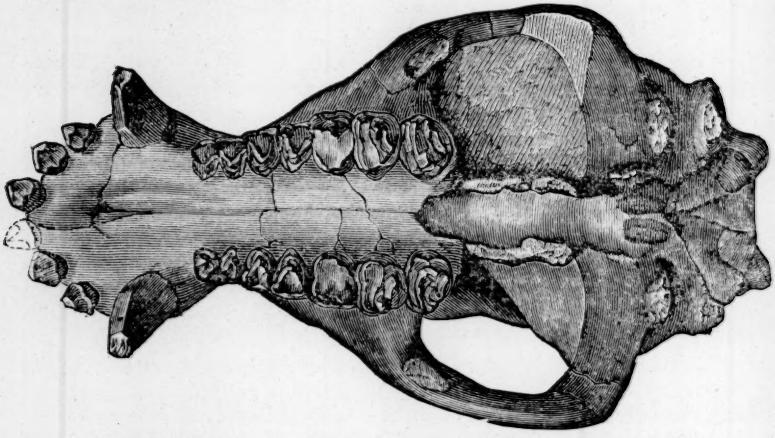
Professor Cope's earlier and brief account of *Phenacodus* has already been reproduced in the February Number of this Magazine. The detailed description now given is a monograph extending to more than sixty pages. The skull in this type is remarkable for the anterior shortening of the nasal bones, so as to give a superior aspect to the nostrils, and these bones extend back closer to the orbit than is usual in Eocene genera, making a slight approach to the Tapir. The slender premaxillary bones are not united in front; and the rami of the mandible have no bony union. The cerebral hemi-

spheres are unusually small, being only one-fourth longer than the cerebellum, from which they are separated by a thick tentorium. In the same way, deep grooves divide the hemispheres from each other, and from the olfactory lobes in front. Nine species are recognized, seven of which are defined by the characters of teeth in the mandible. In the description of *P. Vortmani* indications are given that the spine of the scapula is recurved, as in the Amblypoda and Proboscidea; while the bone differs chiefly from that of the Dinocerata and Proboscidea in the addition of an acromion, which gives a resemblance to some Rodents like the Squirrel. The tuberosities of the humerus are less developed than in most Diplarthra. The proportions of the ulna and radius are similar to those of *Hyrax*, but the distal articulation of the ulna is like that of a Carnivore. The pelvis is intermediate between that of *Hyrax* on the one hand and *Canis* and *Ursus* on the other. The femur is rather more robust than that of the Tapir. The astragalus is small, and resembles that of *Hyrachyus*. This species was about as large as a Bulldog, but with a smaller head and shorter neck, which had more the proportions of a Raccoon. The feet resembled those of the Tapir or Rhinoceros, but with a pair of short toes on each side which did not reach the ground. The tail was like that of a Dog.

The third family of Condylarthra, Meniscotheriidæ, includes the single genus *Meniscotherium*. The animal was about as large as a Fox, less slender than *Phenacodus*, with a short muzzle and large eyes, the robust proportions of a Raccoon, and a large tail. It was one-third larger than the Cape Hyrax, probably a vegetable feeder, and distinguished by its dentition. The upper molars have intermediate tubercles, of which the anterior are crescent-shaped, the posterior oblique. The inferior molars and last premolar have two V-shaped folds. The brain cavity is relatively larger than in *Phenacodus*. Three species of the genus are known. The comparisons chiefly indicate relations with *Phenacodus* and *Hyracotherium*.

The Amblypoda next claim attention. This group comprises mammals with small cerebral hemispheres, which leave the olfactory lobes and cerebellum exposed. The species have short plantigrade feet, terminating in the known genera in five digits, which have flat hoof-bearing terminal phalanges. The seven bones of the carpus are distinct. The molar teeth have wide crowns and crests invested with enamel. The structure of the feet indicates an affinity to the Proboscidea, which is most obvious in the hind foot, the principal difference being that, while the navicular bone extends over the distal end of the astragalus in Proboscidea, the navicular bone is so short in Amblypoda as to allow the cuboid to come in contact with the astragalus. The nearest approach to this condition of the Amblypoda is seen in the Miocene Perissodactylate genus *Symborodon*, where the cuboid and navicular facets are flat, and separated by an oblique line, so as to be similarly incapable of hinge-like movements. In the fore foot the difference between Amblypoda and Proboscidea consists in the alternating position of the elements of the two carpal rows. This alternating condition is usual in the cold-blooded

Vertebrata; and is characteristic of the other existing orders of hoofed Mammals, while in the Proboscidea and Hyracoidea the elements of the two rows of carpal bones have an opposite and longitudinal mode of arrangement. In Amblypoda the plan of construction of the fore foot is about equally related to Proboscidea, Perissodactyla, and Artiodactyla. The brain shows affinities with Cheiroptera, Insectivora, and Edentata. In this relation, the forms of the teeth in some Insectivora show interesting resemblances to the fossil genera *Coryphodon* and *Bathyopsis;* while the small smooth cerebral hemispheres and relatively large size of the optic and olfactory lobes in Amblypoda make a nearer approximation to the Creodonta than to any existing group of Mammals. On the whole, the Amblypoda are to be classed as the most generalized order of hoofed Mammalia. They preceded the other groups in time, and may therefore hold an ancestral relation to them. The order is divided into two suborders; first, the Pantodonta, which has superior incisor teeth and a third trochanter to the femur; secondly, the Dinocerata in which both these characters are absent. Both groups have short cervical vertebræ without ball and socket-joints, intermediate in character between those of Proboscidea and other Ungulates,—characters with are repeated in the scapula, ilium and many details of the skeleton.



Skull of *Coryphodon elephantopus*, $\frac{2}{3}$ natural size, seen from below.

The Pantodonta in America comprises five genera, *Bathmodon*, *Ectacodon*, *Manteodon*, *Coryphodon*, and *Metalophodon*, and are limited at present to the Wasatch beds in the Rocky Mountain region. *Metalophodon* may possibly be identical with *Bathmodon*, since its feet are at present unknown. In the Pantodonta the symphysis of the mandible is furnished with teeth. The upper surface of the astragalus is flat or concave in the middle, and turned inward; it has a large vertical fibular facet,—characters which are shared with the Dinocerata. The coracoid process of the scapula is

produced into a curved hook. The neck is longer than in the Dinocerata.

The genus *Manteodon* has two interior cusps to the last upper molar tooth, and all the upper molars have a marked V shape. *Ectacodon* has only one inner cusp, and one external cusp to the last upper molar, while only the two anterior molars have the posterior V form. *Coryphodon* has no external cusp; and the astragalus is transverse, with an internal hook. This genus is thought to have resembled the Bears in aspect more than any living animals, except that their feet were more like those of the Elephants. The feet indicate a heavy elephantine type of movement, owing to the inflexibility of the ankle. The species varied in size between the bulk of a Tapir and that of an Ox; they were omnivorous, though armed with tusks in both jaws, which are fully as marked as those of Carnivora. There are about twelve American species, some of which are well known from New Mexico. They are distinguished chiefly by relative length of the premaxillary bones, and variations in development and form of the cusps and tubercles of the teeth.

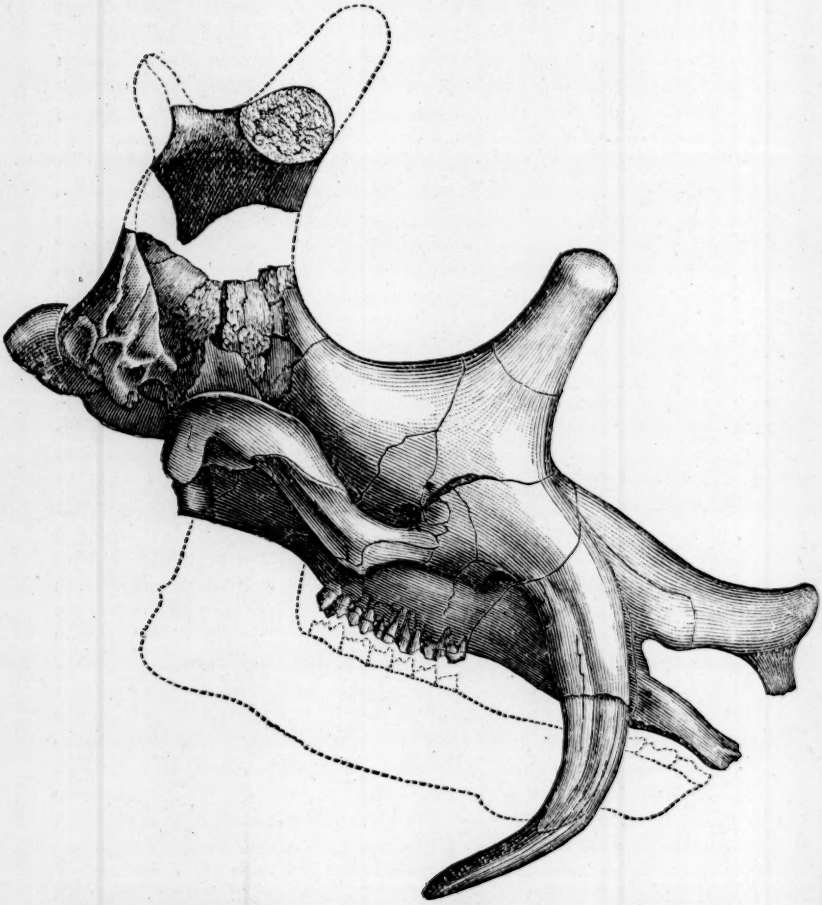
The material for an account of this genus is less full than in Professor Cope's report in Lieut. Wheeler's survey. The species *C. elephantopus* most nearly approaches the genus *Manteodon*, and is defined by the inner half of the posterior crest of the hinder upper molar, forming a V shape, like that of the penultimate molar. The profile of the skull is Tapiroid; the frontal and parietal bones are wide above, so as to overhang the temporal fossæ. The jaw is contracted behind the canine teeth, and the expansion of the premaxillary region is rounded. The zygomatic arch widens, so that the malar bone is carried out laterally far beyond the plane of the maxillary bone. All traces of sutures are obliterated, and the posterior half of the head is roughened above by shallow pits and wrinkles like those seen in many Reptiles. The palatal surface is widest between the posterior incisors. The interspaces between the incisor teeth are as wide as their roots. The large canine teeth are well worn on the anterior face, and the molars are well worn by mastication. *Bathmodon* is an allied genus, in which the astragalus is subquadrate, narrower, and wants the internal hook seen in *Coryphodon*. At present the skull is unknown, and it is possible that some species of *Coryphodon* may belong to this type.

*Bathmodon pachypus* is the only Coryphodont with the pelvis well preserved. The wide peduncles of the ilia resemble those of the Elephant; and if the crest of the ilium of the Camel were more convex, it would resemble *Bathmodon*. The peduncle is stouter than in the Horse, Tapir, or Pig. The limb bones appear to be more robust than in species of *Coryphodon*. *Metalophodon* differs from *Coryphodon* in the structure of its molar teeth, though the dental formula is the same. All the premolars have the single external V pattern; the first upper molar only has two external Vs, of which the anterior is represented by a subconical cusp, while the posterior V is large. The genus is known from two species.

The next suborder, Dinocerata, is especially distinguished from the

Proboscidea by the small size of the cerebral hemispheres, and the double distal articulation of the astragalus, in which the facets for the cuboid and navicular bones are nearly equal. There is less difference between the molar and premolar teeth in this group than in the Pantodonta. In the upper jaw the crowns of the molars have crests with a V pattern, and the lower molars consists of a ⋁ directed outward, and a heel. Professor Cope recognizes four genera based on characters of the mandible; these are named *Eobasileus*, *Loxolophodon*, *Bathyopsis* and *Uintatherium*. *Eobasileus pressicornis* and *E. furcatus* represent the type in which some of the cervical vertebræ are flat and short as in Proboscidea. The muzzle is short; the occipital and parietal crests are remarkably developed, and the proportions of the head somewhat resembled those of Rhinoceros, though the horns and tusks give it a different aspect. *Loxolophodon* is one of those genera concerning which the priority of nomenclature is

*Loxolophodon cornutus.*



disputed, the author claiming to have named it 19th August, 1872, while he finds no earlier date for the *Tinoceras* of Marsh than the following month; but Marsh claims to have published his name on the same day. *Loxolophodon* has a long compressed head with a roof-shaped muzzle, over which is a bilobed protuberance at the end of the nasal bone. A second pair of horns stands over the orbits, each formed externally from the maxillary, and internally from the nasal bone. Behind this the margin of the temporal fossa rises in a way that is considered to indicate another horn. Three species, *L. cornutus*, *L. galeatus* and *L. spierianus*, are distinguished by characters of the horn-cores.

*Loxolophodon cornutus* has a narrow cranium four times as long as its middle width. The diverging horn-cores are in front of the middle length, each with a triangular base. The frontal bones descend behind the horns. There is no bony septum between the anterior nares. The teeth are remarkable for the exposure of their slender roots, as well as for their small size. The grinding surface of the first premolar tooth appears to consist of a worn crescent and an inner tubercle, while the other premolars are transversely arrow-shaped. All the molars have three roots. This type was similar in form and proportion to the Elephant, with somewhat shorter stouter limbs, and a small tail. The neck was a little longer than in Elephants, but shorter than in the Rhinoceros type. The animal stood almost six feet high at the rump, while the height at the anterior limb is estimated at seven feet five inches. The individual from which these measurements are taken may not, however, have reached its full size. Teeth indicate it to have been a vegetable feeder. It is remarkable that the orbits have no distinctive outline, while the eyes were so overhung by the horns that the view was chiefly lateral, for the muzzle and cranial crest obstructed the view in front and behind. This species was found in the bad lands of Wyoming, 8500 feet above the sea.

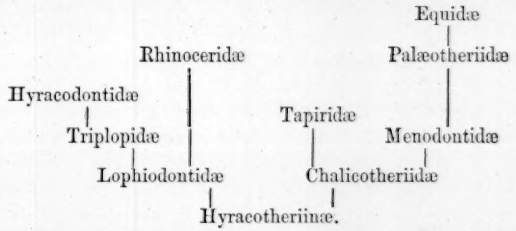
*Uintatherium* has the cervical vertebræ more elongated. This genus is regarded by the author as identical with that which Professor Marsh has rendered classical as *Dinoceras*, though Professor Marsh separates *Dinoceras* from it as having three instead of four lower premolars. Leidy published *Uintatherium* in August, 1872; Marsh, *Dinoceras*, in September, 1872. Three species are here described. Another genus, *Bathyopsis*, is founded on a mandible with the three molar teeth and four premolars constructed on the same pattern. It differs from *Uintatherium* and *Loxolophodon* in the much greater vertical depth of the inferior expansion of the ramus of the mandible, along the whole length of which it extends. The inferior molars are constructed on the plan of those of insectivorous and marsupial Mammals, so as to suggest that the animals fed on Crustacea, large Insects, and perhaps thin-shelled Molluscs.

A third suborder of the Amblypoda named Taligrada is believed to be indicated by a single species of a genus *Pantolambda*. This suborder is defined chiefly on the characters of the astragalus, for while that bone in the Pantodonta has no head, in this type it has a

head distinct from the trochlear and distal articular facets. The cusps of the upper and lower molars develope into Vs. All the vertebræ have flat articulations. There is no inter-trochlear ridge to the humerus; and the femur has a third trochanter. Excluding the characters of the astragalus, there are resemblances to the Condylarthra in the narrow ilium, and in the molar teeth having but one internal lobe; but the dentition is especially like that of the Amblypoda, and there are resemblances to the Pantodonta in the premaxillary teeth, the short flat cervical vertebræ, and the third trochanter to the femur; but the characters of the astragalus are rather like those of the Periptychidæ and the Proboscidea. In *Pantolambda* the brain indicates small nearly smooth hemispheres, extending with little contraction into a rather large cerebellum, while the olfactory lobes are produced anteriorly at the extremity of a rather long isthmus. The dentition would indicate *Pantolambda* to be the ancestor of the Coryphodonts. The superior molars are all triangular from having a single internal cusp. This type of tooth at the present day is found among Insectivorous and Carnivorous Marsupials, in the Insectivora, and in the tubercular crowns of some Carnivora; and among Ungulates it is found in the molars of the Coryphodonts, and in the last upper molar of the Dinocerata. The only species is *Pantolambda bathmodon*, in which the hinder part of the skull is Opossum-like, and the nasal bones give an obtusely roof-shaped form to the muzzle.

The Perissodactyla are well represented in the North American Tertiaries. The group may be described as intermediate in dentition between the Proboscidea and the lowest Selenodont Artiodactyla. On dental characters Professor Cope recognizes ten families arranged into four divisions. First, animals with the anterior crescent of the upper molars shortened, and not distinguished from the posterior crescent by an external ridge, with cross-crests to the inferior molars, and with premolars distinct from the molars. This comprises the Lophiodontidæ, in which the toes are 4–3; and the Triplopodidæ, in which the toes are 3–3. Secondly, a division in which, while the exterior crescents of the upper molars, and the cross-crests of the lower molars, remain as in the first division, while the upper molars and premolars are alike, and furnished with cross-crests. Under this type are comprised the Hyracodontidæ, in which the mastoid bone enters into the external wall of the skull; and the Rhinoceridæ, in which the mastoid bone is excluded from the wall of the skull, by contact of the squamosal bone with the occipital bone. The third division has the exterior crescentic crests of the upper molars subequal and distinct, with cross-crests to the inferior molars. This type comprises the Tapiridæ, in which the upper molars and premolars are alike furnished with cross-crests, and with the toes 4–3. The last division has the nearly equal external crescentic crests of the upper molars separated by an external ridge, while the inferior molars are furnished with crescents. First in this group are placed the families with superior premolars different from the molars, and with only one internal cusp. The

Chalicotheridæ have the toes 4–3, and the Macraucheniidæ have the toes 3–3. And secondly come families in which the molars are like the premolars, but with two internal lobes; and among these the Menodontidæ have the digits 4–4, the Palæotheriidæ have the digits 3–3, while the Equidæ have the digits 1–1. These families include 46 genera and 192 species. The author remarks that the Lophiodontidæ and Chalicotheridæ are prevalent in the Eocene; the Rhinoceridæ and Palæotheriidæ characterize the Miocene; while the Tapiridæ and Equidæ are chiefly found in the latest Tertiary epochs. The following table exhibits the relations of the families with each other.




The Lophiodontidæ comprises a large number of species, all of which, with one exception, are limited to the Eocene rocks. Among living animals the Tapirs most nearly resemble them. They range in size from that of a Rabbit to the bulk of an Ox. *Lophiodon* is limited to Europe; *Hyrachyus*, *Hyracotherium* and *Pliolophus* to Europe and North America; while *Systemodon*, *Heptodon*, *Helaletes*, and *Colonoceras* are only found in North America. All these genera are classified and defined by dental characters. *Systemodon* is allied to *Hyracotherium* and *Pliolophus*; but instead of having the wide diastema behind the canine tooth, seen in *Hyracotherium*, there is no interspace at all. The dental formula appears to be the same, and the differences are in the form and arrangement of the cusps. The genus is represented by two species.

*Hyracotherium* is admirably known from six American species; it shows three diastemata, behind the third incisor, the canine, and the first premolar in the upper jaw; and two in the lower jaw, behind the canine, and the first premolar. The species of this genus differ in the relative development of the intermediate tubercles of the upper molars, in the distinctness of the tubercles of the lower molars, the varying lengths of the diastemata, and the development of the cingula. The form of the head is very like *Anchitherium*, and the cingulum of the upper molar teeth is represented in *Anchitherium* by a ledge, while the principal bones of the limbs are much alike in both genera, so that there are some grounds for suggesting an ancestral relation between them. The coracoid process of the scapula in *Hyracotherium* is incurved as in *Coryphodon* and *Anchitherium*, and is larger than in its allies *Triplopus* and *Hyrachyus*. The humerus, especially in its proximal end, has much in common with these genera, and in the simple groove for the biceps is like *Tapirus* and *Anchitherium*. The carpus includes eight bones, and is more like that of *Hyrachyus* than

*Triplopus*, owing to the second metacarpal having a considerable contact with the os magnum. The bones of the hind limb have most resemblance with *Hyrachyus*; but the femur of *Hyracotherium* has the great trochanter larger, so as to project far above its head. The third trochanter is large, but not so long as in the Tapir and the Horse. The species range in size from *H. index*, which is equal to the Kit Fox, to *H. craspedotum*, which is equal to the Coyote. Three species are found in the Wasatch beds, three in the Wind River beds, and one in the Bridger beds.

The genus *Pliolophus* is said to differ from *Hyracotherium* only in having two tubercles on the heel of the fourth premolar tooth instead of one. The genus is intermediate between *Hyracotherium* and *Lophiotherium*. Six species have been defined, including Professor Owen's original type, and five of these are North American. The genus *Heptodon* is essentially a Lophiodon with seven superior molars: three species are now described. *Hyrachyus* has no heel to the last true molar; its lower canines form a continuous series with the incisors, but are separated from the premolars by a diastema. The affinities of the skeleton are, first, with the Rhinoceros type; secondly, with the Tapirs, and least with the Horses. Equine characters are seen in the articulation of the lumbar vertebræ, Rhinocerontic characters in the form of the sternum; but the affinities are strongest with *Hyracotherium*. The carpal articulation of the ulna is not so small as in *Triplopus* and *Anchitherium*. Nine species have been recognized; three are fully described, and the author points out in detail the differences between *Hyrachyus eximius* and *Tapirus roulini*. *Triplopus* is a genus nearly allied to *Hyrachyus* in its dentition, but appears to have a third transverse crest in the first true molar, and there is a difference in the number of digits in the fore foot. The rudimental character of the fifth metacarpal, which in *Hyrachyus* is well developed, and carries a digit, is the ground for making *Triplopus* the type of another family. It is regarded as connecting the Lophiodonts with the Rhinoceroses; but the structure of the true molars and the character of the feet place it between those families. Only one species is known with certainty.

A synopsis is given of the generic characters of the Rhinoceridæ, based on the number of digits, the dentition and the conditions of the skull connected with the development of horns. The Tapiridæ is in the same way briefly defined, but no species of either group is described.

The Chalicotheriidæ is a group of eight genera. The symmetrical external Vs of the upper molars and the double Vs of the inferior molars distinguish them from the Lophiodontidæ; but they are not so clearly defined from the Menodontidæ. Among its genera, *Pachynolophus* and *Chalicotherium* are found in Europe, *Nestoritherium* in Asia, while North America yields *Ectocion*, *Leurocephalus*, *Palæosyops*, *Lymnohyus* and *Lambdotherium*, all of which are defined by dental characters. *Ectocion* is only known from the teeth; *Palæosyops* differs from *Palæotherium* in the isolation of the internal cones of the upper molars from the external longitudinal crescentic crests,

and in having but one inner tubercle instead of two on the last three premolars. The molar dentition approaches towards *Menodus*. The pelvis was more Palæotheroid than Tapiroid. This genus, which is limited to the Eocene, is illustrated by descriptions of four species. *Limnohyus* differs from the type last mentioned in having two conical tubercles instead of one on the inner series in the last upper molar. Two species are described. *Lambdotherium* is only known from its dentition; and the author remarks that if the ridges which are rudimented in the molars of *Hyracotherium* were developed, and the external cusps of the superior molars flattened externally, the result would be the dentition of *Lambdotherium*. Three species are described. Brief notices follow, without description of species, of the genera contained in the Macraucheniidæ, Menodontidæ, Palæotheriidæ and Equidæ.

The Perissodactyla in the Eocene rocks of the Western Territories are thus seen to exhibit many and varied types, but the Artiodactyla are scantily developed in the Eocene period. Only two or perhaps three genera of Hogs have come under Professor Cope's notice, and *Pantolestes* is the only type described. The tarsal characters are in general similar to those of *Dicobune*, but this genus differs in having but one inner tubercle to the upper molars and one external tubercle to the upper premolars, and differs from the Anoplotheres in the presence of external digits. Seven species are defined and described. This concludes the account of about 250 species of Eocene Vertebrata, though supplements include descriptions of a few Fishes, Reptiles, Birds, and Mammals, which were received too late to be comprised in the body of the work. A notice of the Miocene fauna from the White River and John Day beds must be reserved for another notice, after which it may be convenient to discuss the scientific results of the author's work. H. G. Seeley.

## REPORTS AND PROCEEDINGS.

### British Association for the Advancement of Science. Fifty-sixth Meeting, Birmingham, 1886.

#### Section C.—Geology.

*President* :—Professor T. G. Bonney, D.Sc., LL.D., F.R.S., F.S.A., F.G.S.

*Vice-Presidents* :—Professor C. Lapworth, LL.D., F.G.S.; H. Woodward, LL.D., F.R.S., F.G.S.; Rev. H. W. Crosskey, LL.D.; Sir Julius Von Haast, K.C.M.G., D.Sc., F.R.S.; Prof. E. Hull, LL.D., F.R.S.; W. Mathews, M.A., F.G.S.; Dr. A. R. Selwyn, C.M.G., F.R.S.

*Secretaries* :—W. Jerome Harrison, F.G.S.; J. J. H. Teall, M.A., F.G.S.; W. Topley, F.G.S. (*Recorder*); W. W. Watts, B.A., F.G.S.

Titles of Papers read September 2nd to 8th, 1886.

Address by the President.

*Prof. C. Lapworth.*—Geology of the Birmingham District.

*W. J. Harrison.*—On the Discovery of Rocks of Cambrian Age at Dosthill, in Warwickshire.

*Prof. C. Lapworth.*—The Cambrian Rocks of the Midlands.

*W. H. Waller.*—On the Petrography of the Volcanic and associated Rocks of Nuneaton.

*A. Strahan.*—On the Rocks surrounding the Warwickshire Coal Field, and on the base of the Coal-Measures. With an Appendix on the Igneous Rocks of the Neighbourhood, by *F. Rutley.*

*W. Matthews.*—On the Halesowen Coal Boring.

*F. G. Meacham and H. Insley.*—On the Thick Coal and the Trias north of Birmingham, and on the old South Staffordshire Coal Field.

*Dr. H. W. Crosskey.*—Report on the Erratic Blocks of England and Wales.

*Dr. H. W. Crosskey.*—On the Glacial Formations of the Birmingham District.

*Rev. W. Tuckwell.*—On the Glacial Erratics of Warwickshire and Leicestershire.

*A. T. Evans.*—The Fossiliferous Bunter Pebbles contained in the Drift of Moseley, etc.

*Prof. W. Benton.*—On the Surface Subsidences caused by Coal Mining.

*Dr. H. Woodward and R. Etheridge.*—To exhibit some Organisms met with in the Clay-Ironstone Nodules of the Coal-Measures of the Neighbourbood of Dudley.

*S. A. Adamson.*—Notes on the Discovery of a large Fossil Tree in the Lower Coal Measures at Clayton, near Bradford.

*Rev. P. B. Brodie.*—On the Discovery of Fossil Fish in the New Red Sandstone (Upper Keuper) in Warwickshire.

*Rev. P. B. Brodie.*—On the Range, Extent, and Fossils of the Rhætic Formation in Warwickshire.

*W. J. Harrison.*—On a Deep Boring for Water in the New Red Marls (Keuper Marls) near Birmingham.

*Dr. W. T. Blanford.*—Notes on a Smoothed and Striated Boulder from a Pretertiary Deposit in the Punjab Salt Range.

*A. B. Wynne.*—On a Facetted and Striated Pebble from the Olive Conglomerate of Chil Hill, in the Salt Range, Punjab.

*Prof. E. Hull.*—Notes on the Problems now being investigated by the Officers of the Geological Survey in the North of Ireland, chiefly in Co. Donegal.

*Dr. C. Callaway.*—Notes on the Crystalline Schists of Donegal.

*Prof. C. Lapworth.*—The Ordovician System in Shropshire.

*Prof. T. McK. Hughes.*—On the Silurian Rocks of North Wales.

*Prof. T. McK. Hughes.*—Notes on some Sections in the Arenig Series of North Wales and the Lake District.

*J. E. Marr.*—On the Lower Palæozoic Rocks, near Settle.

*A. J. Jukes-Browne.*—Note on a Bed of Red Chalk in the Lower Chalk of Suffolk.

*Dr. C. Le Neve Foster.*—Manganese Mining in Merionethshire.

*J. W. Davis.*—On the Exploration of Raygill Fissure, Yorkshire.

*C. Beale.*—On the Dolerites of Rowley Regis.

*C. J. Woodward.*—On the Mineral District of Western Shropshire.

*F. D. Adams.*—On the Anorthosite Rocks of Canada.

*Prof. H. Carvill Lewis.*—On a Diamond-bearing Peridotite, and on the Genesis of the Diamond.

*J. J. H. Teall.*—On the Metamorphosis of the Lizard Gabbros.

*Prof. J. F. Blake.*—Introduction to the Monian System of Rocks.

*Prof. J. F. Blake.*—On the Igneous Rocks of Llyn Padarn, Yr Eifl and Boduan.

*J. H. Player.*—On an accurate and rapid method of estimating the Silica in Igneous Rocks.

*J. Hopkinson.*—On a new form of Clinometer.

*H. B. Stocks.*—On Concretions.

*W. Pengelly.*—On a Scrobicularia Bed, containing Human Bones, at Newton Abbot, Devonshire.

*W. W. Watts.*—The Corndon Laccolites.

*Prof. T. Rupert Jones.*—Report on the Fossil Phyllopoda of the Palæozoic Rocks.

*E. T. Hardman.*—On the Discovery of *Diprotodon Australis* in Tropical Western Australia (Kimberley District).

*Prof. J. W. Sollas.*—On the past and present Bathymetrical Distribution of the *Lithistida*.

*C. E. De Rance.*—Report on the Circulation of Underground Waters.

*Prof. G. A. Lebour.*—On the Stratigraphical Position of the Salt Measures of South Durham.

*G. H. Morton.*—On the Carboniferous Limestones of the North of Flintshire.

*Hugh Miller.*—On the Classification of the Carboniferous Limestone series—Northumbrian type.

*W. A. E. Ussher.*—The Culm Measures of Devonshire.

*A. R. Hunt.*—Denudation and Deposition by the Agency of Waves experimentally considered.

*C. E. De Rance* and *W. Topley.*—Report on the Erosion of the Sea-Coasts of England and Wales.

*Prof. W. I. Macadam* and *J. S. Grant-Wilson.*—On Deposits of Diatomite in Skye.

*Dr. H. Hicks.*—Reports on the Exploration of the Tremeirchion Caves, North Wales.

*Prof. T. McK. Hughes.*—On the Pleistocene Deposits of the Vale of Clwyd.

*Prof. H. Carvill Lewis.*—Comparative Studies upon the Glaciation of North America, Great Britain, and Ireland.

*Henry Johnson.*—On the Extension and Probable Duration of the South Staffordshire Coal Field.

*Sir J. W. Dawson.*—On the Relations of the Geology of the Arctic and Atlantic Basins.

*Dr. G. M. Dawson.*—On the Rocky Mountains, with special reference to that part of the Range between the 49th Parallel and the Head-waters of the Red Deer River.

*F. D. Adams.*—On the Coal-bearing Rocks of Canada.

*Prof. T. Rupert Jones.*—On the Coal Deposits of South Africa.

*Prof. W. Boyd Dawkins.*—On the Kerosine Shale of Mount Victoria, New South Wales.

*Sir J. Von Haast.*—On the Character and Age of the New Zealand Coal Fields.

*E. W. Bucke.*—On the Geysers of the Rotorua District, N. Island of New Zealand.

*Prof. J. W. Judd,*—Notes to accompany a Series of Photographs, prepared by *J. Martin, Esq.*, to illustrate the Scene of the recent Volcanic Eruption in New Zealand.

*E. T. Hardman.*—On the Geology of the newly-discovered Goldfields of Western Australia (Kimberley District).

*Richard Meade.*—Statistics of the Production and Value of Coal raised within the British Empire.

*W. A. E. Ussher.*—The Relations of the Middle and Lower Devonian in West Somerset.

*W. Whitaker.*—Supplementary Note on two Deep Borings in Kent.

*Prof. W. Boyd Dawkins.*—On the Westward Extension of the Coal-measures in South-Eastern England.

*J. S. Gardner.*—Report on the Fossil Plants of the Tertiary and Secondary Beds of the United Kingdom.

*Sir J. W. Dawson.*—On Canadian Examples of supposed Fossil Algæ.

*Prof. T. McK. Hughes.*—On *Bilobites.*

*Prof. W. C. Williamson.*—On recent Researches amongst the Carboniferous Plants of Halifax.

*W. Topley.*—Notes on the recent Earthquake in the United States; including a telegraphic despatch from *Major Powell,* Director of the United States Geological Survey.

*Prof. John Milne.*—Report on the Earthquake and Volcanic Phenomena of Japan.

*Dr. H. J. Johnston-Lavis.*—Report on the Volcanic Phenomena of Vesuvius.

*Rèv. A. Irving.*—On the Heat of the Earth as influenced by Conduction and Pressure.

*Rev. A. Irving.*—A Contribution to the Discussion of Metamorphism in Rocks.

*J. Gunn.*—On the Influence of the Axial Rotation of the Earth on the Interior of its Crust.

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List of Papers bearing upon Geology read in other Sections.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

Address by the President, *Prof. G. H. Darwin.*—(Geological Time, etc.)

*John Hopkinson.*—An Improved Form of Clinometer.

SECTION B.—CHEMICAL SCIENCE.

*Dr. H. R. Mill.*—Chemistry of Estuary Water.

*Dr. O. W. Huntingdon.*—The Crystalline Structure of Iron Meteorites.

SECTION D.—BIOLOGY.

Address by the President, *W. Carruthers.*—(Pliocene Plants, etc.)

SECTION H.—ANTHROPOLOGY.

*Dr. Henry Hicks.*—On Evidence of Pre-Glacial Man in North Wales.

*Prof. W. Boyd Dawkins.*—On the Recent Exploration of Gop Cairn and Cave.

*Charles N. Bell.*—Remains of Pre-historic Man in Manitoba.